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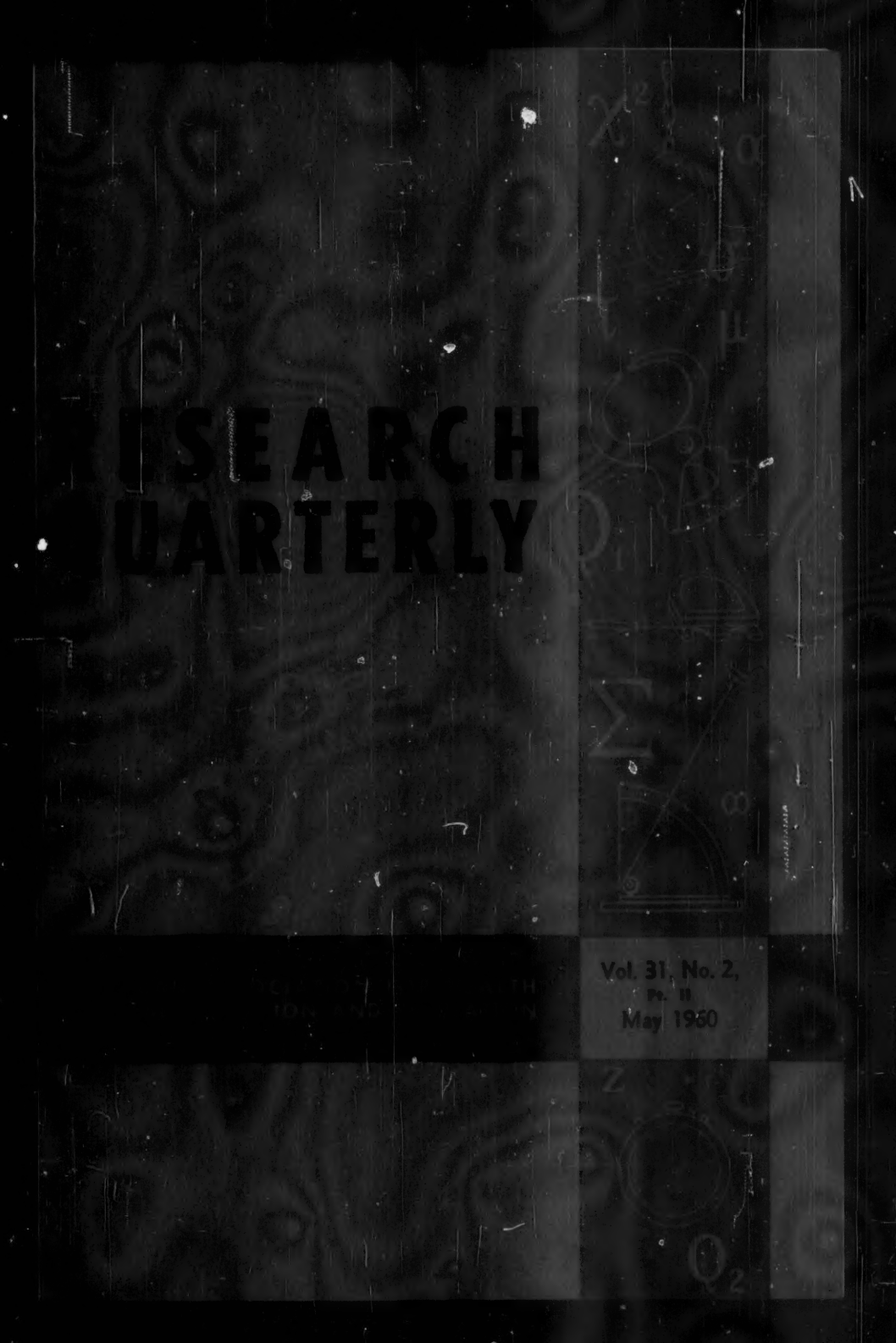

Vol. 31, No. 2,
Pt. II
May 1960

AMERICAN ASSOCIATION FOR HEALTH, PHYSICAL EDUCATION, AND RECREATION

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Besides special publications and yearbooks, it publishes a monthly JOURNAL and the RESEARCH QUARTERLY.

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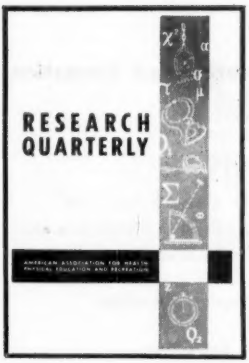

The Research Quarterly
of the American Association for Health,
Physical Education, and Recreation
A department of the National Education Association
1201 Sixteenth St., N.W., Washington 6, D. C.

VOL. 31, NO. 2, PART II MAY 1960

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THE CONTRIBUTIONS OF PHYSICAL ACTIVITY TO HUMAN WELL-BEING

Published in March, May, October, and December by the American Association for Health, Physical Education, and Recreation (a department of the National Education Association), 1201 Sixteenth Street, N.W., Washington 6, D. C. Subscription available to libraries, institutions, and departments at $5.00 per year. *Subscriptions to individuals are available only through membership in AAHPER.* Of the membership ($15.00 per year), $4.00 covers subscription to the *Quarterly.* Of the student membership ($6.00 per year), $1.50 is for subscription to the *Quarterly.* Single copies $1.25. Send membership dues or subscription fees to AAHPER Circulation Department, 1201 Sixteenth Street, N.W., Washington 6, D. C.

Manuscripts are to be sent to the *Research Quarterly,* AAHPER, 1201 Sixteenth Street, N.W., Washington 6, D. C. Authors should follow the form prescribed in the "Guide to Authors" that appears each year in the October issue of the *Quarterly.*

Second class postage paid at Washington, D. C., and at additional mailing offices.

The Contributions of Physical Activity to Human Well-Being

Foreword

THIS SUPPLEMENT to the regular issues of the RESEARCH QUARTERLY is a project of the Research Council of the American Association for Health, Physical Education, and Recreation, to commemorate the 75th anniversary of the Association. It contains reviews of research about physical activity and its effects upon well-being. The reviews present the contributions of physical activity to physical health, social and psychological development, skill learning, growth, and rehabilitation.

Physical education, recreation, and health education research are not assigned to separate articles, but are placed under appropriate headings. The reviewers have interpreted the findings for readers in all three areas of specialization.

It is the intent of this supplement to inquire into the validity of objectives which have been endorsed in our allied fields. Physical activity is alleged to be a valuable medium for attaining goals important to human well-being. The professions of health education, physical education, and recreation stress the contributions of physical activity, and their objectives proclaim the attainment of physical, mental, social, and emotional health.

In the past, these objectives have been supported on empirical and logical grounds, with reasonable acceptance inside and even outside the professions. However, the ultimate basis for these objectives is experimental evidence which demonstrates that physical activity can contribute to human well-being. The supplement will serve to consolidate the evidence for these objectives and to point the way for further research.

Each article covers a single major objective, and the emphasis has been placed on values rather than effects. The intent is to present the demonstrated values or contributions of physical activity and not merely the effects of physical activity. Since space does not permit detailed explanations of research, the authors have avoided explanations of sampling procedures, statistical procedures, testing procedures, and the like. They have concentrated on the findings and their implications for the validity of objectives in the related fields.

A steering committee of Research Council members planned the supplement, selected the writers, and served as associate editors during the prepara-

tion of the reviews. While regretting any omissions which usually plague such cooperative efforts, the steering committee is confident that these reviews do present an accurate description of knowledge in these areas.

The profession owes a debt of gratitude to the authors of these review articles for the time and effort they spent so generously in producing this supplement.

THE STEERING COMMITTEE

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Introduction

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CHILDREN'S PLAY, games of all kinds, competitive athletics, the dance, and various forms of exercise programs provide many opportunities for influencing the human organism in its physical growth, in its mental-emotional development, and in its social adjustment. Spontaneous participation in such activities has undoubtedly, throughout the ages, greatly influenced the more or less unguided development of young and old.

In more recent times man has recognized the special potentialities of physical activities and has begun to employ them with special purposes in mind. Sometimes he has shown primary interest in them as a means of entertainment; sometimes as a device to establish his superiority over a competitor; sometimes as experiences in the rearing of his young, in the constructive maintenance of adults, in the reconstruction of persons subjected to the debilitating effects of disease or disuse, and in the fostering of attitudes and habits useful to the individual and society.

Efforts to use activities to produce changes in people have not always enjoyed the support of sound foundations. Often loyalty to tradition, misconceived goals or ignorance; sometimes enthusiasm engendered in the laboratory of one-man-experience; at times the presence of equipment "spoiling" to be used; and occasionally perhaps school aggrandizement, the loudest voice, or even self-interest have each in turn dictated policy and prescribed the program of activities to be followed.

Where there are differences of opinion that involve programing the time of others and the expenditure of funds, the generations that follow upon pioneers and enthusiasts demand proof for claims and facts for guides. Today we are inclined in most areas of human endeavor to accept as ultimate authority neither the shining countenance of the zealot nor the wisdom of grey beards. We turn instead to the findings of research to guide our steps. Although fully committed to this scientific procedure as man's surest way of discovering truth, it would be unwise to wait until the scientific method had produced all the answers. Where facts are lacking, programs based on the best available opinion must continue until more dependable guides are discovered.

Slowly but surely, research is seeking to establish facts and discover relationships that exist between experiences in physical activities and the physical, mental, emotional, social, and spiritual outcomes generally ascribed to them. This supplement is dedicated to the task of bringing the reader abreast of present knowledge of these facts and relationships. In so doing it discloses

Definitions

When a program of physical activities is conceived in accord with today's best knowledge and administered by persons aware of the many-sided potentialities of these activities, and when both the planning and the execution of the program are aimed to serve the physical, mental, and social well-being of the participant—then the effort may be called *physical education.*

When the program centers on the perfection of the physical organism and its goal is attainment of some ideal of strength, beauty of physique, robust vitality, or perfection of physical performance in the individual, with little or no conscious concern for mental, emotional, social, or spiritual outcomes, it may appropriately be called *physical culture.*

When major emphasis is on the constructive use of leisure to supplement and correct the modern day personality-fragmenting stresses of earning a livelihood, when diversion is a most highly valued outcome, and when activities are usually self-selected and of an all absorbing nature—then the designation *recreational program* is aptly used.

When the primary purpose of the activity is to gain ends that come from superior performance or overcoming an opponent and only secondary attention is given the needs of the individual as a person or citizen, then the effort is aptly called *coaching,* be it in the field of football or dance. Competitive athletics or other such emphases on the development of high-level skills become physical education when thereby the real, developmentally significant needs of the participants are best met.

the peaks of established facts and the valleys of remaining uncertainty. Thus it should serve as both guide to practice and stimulus to further research.

Those who have toiled to produce these bits of knowledge and those who in the preparation of these reviews have laboriously sought out these bits and assembled them in usable patterns deserve our sincere thanks. This will be best shown when those in positions of administrative responsibility shape programs in accord with such patterns, when those who teach and lead others in activity programs are guided by them in every contact with others, and when those in position to make studies will use this volume as a starter's block from which to take off to new discovery through careful study.

The Contributions of Physical Activity to Physical Health

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THE INTERACTIONS and interdependency of the various components of the human being are better appreciated today than ever before. Intellectual, emotional, social, and spiritual, as well as physical factors, are recognized as integrated aspects of personality. What affects one phase of personal health must also exert an influence, in some measure, on other aspects. Thus it is impossible to separate physical from emotional factors in discussion of the contributions of exercise[1] to physical health. Consequently, *physical* is used throughout to connote the predominant consideration or chief emphasis, with full realization that concomitant influences on the other aspects of health are always at work. Only indirect reference is made to these other preventive and therapeutic values of exercise since its contributions to mental health, to growth, to skill, and to rehabilitation, are discussed elsewhere in this volume.

Confusion of Effects and Benefits. There should be no confusion concerning the *effects* of exercise and the benefits of exercise. Dukelow (23), following review of medical literature relating to this subject, had this to say:

> Generally, these [papers] discuss controlled observations and research studies which show that at the time exercise is performed it increases muscle volume, steps up the heart rate, alters the tracings recorded by electrocardiography, and causes changes in the speed and volume of respiration. They tell about the effects of exercise on the nervous system, the digestive system, the excretory system, the circulatory system, the musculoskeletal system, and nearly everything else in the body. However, these investigators rarely say whether the observed phenomena are beneficial, harmful, or of no consequence.

This emphasizes the fact that the effects of exercise could presumably be harmful as well as beneficial. Certain studies (41, 81) based on premises difficult for those who value exercise to accept have even suggested that some undesirable outcomes may be possible.

While such studies may be questioned and their limitations pointed out, the fact remains that the case for exercise must be based on sounder grounds than the potential value of temporary physiological adjustments or its training effects for better physical performance. What must be demonstrated is that

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[1]For purposes of this paper, the terms "exercise" and "physical activity" will be used synonymously—"active use (physical) to give practice or training and to cause improvement."

the exercised ("fit" or "conditioned") person lives a more productive and satisfactory life, is better able to cope with the exigencies of modern living, is more resistant to degenerative disease, and at the same time is likely to live as long or longer than his unexercised contemporary.

Multiple Factors in Health Maintenance. Isolation of a single factor, such as exercise, among the many involved in the maintenance of health is exceedingly difficult. For example, examination of a group of older members of a turnverein reportedly indicated their responses to exercise and their general condition compared favorably with those of much younger persons (48). These favorable responses could conceivably be the result of continued gymnastic activity but, with equal logic, could be attributed to constitutional factors. That genetics plays an important role in health is undeniable, and it may be that there are constitutional types that seek physical activity, react favorably to it, and tend to continue exercise into their later years. Thus, while the first hypothesis may seem more tenable, the difficulty of demonstrating it objectively is readily apparent.

Hippocrates, the father of medicine, is said to have made the statement that "exercise strengthens while inactivity wastes" (114). Here succinctly stated is the sum of our knowledge about the physiology of exercise—what we feel and hope exercise can do to give more years to life and more living to the years of life. Hippocrates' statement appears today to be an empirical assertion since we cannot be sure of the observations upon which it was based. However, until recently such empirical "evidence" satisfied all but a few. Now the situation is changed, and proof is demanded of claims made concerning the contributions of physical activity to health.

Van Liere (109), writing about the effect of exercise on the body, comments:

> It is accepted by many people, including physicians, that a certain amount of physical exercise is beneficial to the physical development and health of the human being, and that it increases work capacity and prolongs life. . . . We must not lose sight of the fact that there are many people who apparently enjoy good health, and a long life, and who contribute more than their share to community life without taking any more physical exercise than the nature of their work allows.

In the last decade, a growing body of evidence derived from clinical observations and experimental studies points to definite values for exercise in (a) maintaining desirable weight, (b) preserving the health of the cardiovascular system, (c) aiding the individual to meet emergencies, and (d) prolonging life. It is time to review what seem to be pertinent observations and research in these areas and to appraise the total picture of the contributions of physical activity to physical health.

Exercise and Weight Control

It is now well established that overweight, or obesity, not only shortens life but also contributes to the development of degenerative disease. Surprisingly

enough these findings apply to cancer as well as to cardiovascular disease and diabetes. Life insurance statistics, as well as clinical observations of innumerable obese patients, testify to these facts (20).

The extent to which obesity has been shown statistically to cut down on life expectancy is startling. Even moderate overweight produces a 40 percent higher than normal risk, while marked obesity yields a 70 percent higher death rate for age. Analysis of the mortality ratios for the obese among some 50,000 policyholders of one large insurance company caused its statisticians to observe that: "Weight control appears to be the most practical means at present of preventing or retarding the degenerative diseases of middle and later life" (65).

If exercise can be shown to assist effectively in weight control, its concomitant contribution to health through disease prevention and life extension will then be clear. Sufficient evidence has now become available to leave no doubt but that the level of physical activity does play a major role in weight control.

Exercise Fallacies. Certain nutritionists and some physiologists have suggested and perpetuated two fallacies about exercise in relation to weight control that should be dispelled promptly and properly. These are that exercise expends so few calories that it can hardly help to maintain desirable weight, and that the increase in appetite and food intake that follows physical activity will negate or even impair efforts at weight control through exercise (57).

That both of these assertions are erroneous is demonstrated by the fact that athletes, soldiers in the field, and men engaged in hard labor may consume as much as 6000 calories per day without gaining weight. Recognition of this fact and further evidence of the fallaciousness of the assertions above is provided by the National Research Council's table of recommended dietary allowances. For men a range of from 2400 to 4500 calories per day *depending upon the level of physical activity* is suggested (28).

Caloric Expenditure of Exercise. The measured costs in calories of different types of exercise have been established and vary from walking at about 250 calories per hour to strenuous sports (rowing, wrestling, running), which may consume 1000 calories or more per hour. Being overweight increases the caloric cost of activity in direct proportion; for example, 20 percent of overweight advances the energy expended 20 percent. This is because the overweight person requires more energy to move his body and consequently burns more body reserves than a slimmer person while taking the same amount of exercise (58).

Animal experimentation supports these observations. In obese mice most of the fat storage in the animal stems from inactivity rather than overeating. Animals of normal weight are 50 to 100 times more active than the obese animals (55, 59).

Interestingly, the inactivity precedes and appears to be more the cause than the result of the obesity. The nonobese animals consume nearly as many calories each day as the obese animals but expend the excess over growth and maintenance requirements in physical activity. The overweight animals eat somewhat more and, taking little activity, store the extra calories in fat instead of burning them up through exercise.

Directly related to weight control, obese animals show marked reduction in weight with exercise on the treadmill. Even members of an obese strain gain comparatively little weight when they are regularly active (60).

Growing pair-fed albino rats when exercised one half hour daily (swimming) over a period of from five to eight weeks show significantly less weight gain (30-40 percent) than their sedentary litter mates (40).

Recent studies indicate a definite advantage in reducing weight by exercise as compared with reduction through food curtailment. In animals reduced by exercise, the weight loss was much more lasting than in those reduced by dieting (53).

The findings of animal experimentation have lately been confirmed on human subjects. With induced rhythmic exercise for one hour per day over a ten-week period, the subjects who completed the test demonstrated an average weight loss of over seven pounds per person. This was achieved without the use of drugs, appetite appeasers, or diet (101). A group of overweight college students (men and women) not only lost statistically significant amounts of weight but also made demonstrable gains in muscular strength and power (27). There was no supervision of their diet during the ten-week experimental period.

When daily exercise is vigorous enough, gains in weight can be prevented even when the subjects eat some 6000 calories each day of a diet rich in fat. A marked increase in weight follows promptly when the vigorous exercise is stopped. Obviously, the excess calories are burned up in exercise (52).

A study of the effect on obesity of regular participation in physical recreation has been made by comparing healthy active and inactive businessmen. The active men had heavier fat-free body weights, a lower percentage of body fat, and less of the disuse atrophy usually associated with aging (11).

Exercise, Appetite, and Food Intake. A number of studies indicate that appetite responds to activity only within certain ranges. Both rabbits and rats have been shown to become obese when they are restricted or immobilized; their appetites failed to decrease appropriately with confinement (31, 44).

It has been shown, also, that moderate exercise of short duration does not step up food intake in exercised experimental animals. In fact, habitually inactive animals subjected to exercise for short periods ate somewhat less and lost small amounts of weight. With more vigorous exercise over longer periods, food intake was stepped up, but the extra activity kept the weight constant. When exercise was carried to the point of exhaustion, food intake decreased, the animals lost weight, and their appearance deteriorated (60).

Similar results were achieved in the dog when the experimental animal was alternated between all-day kennel confinement and days including an hour of out-of-kennel exercise. These studies suggest the need for a minimal level of exercise if the appetite is to act properly to balance intake with body requirements (80).

Observations of overweight adults seem to indicate a comparable pattern in man. The start of obesity uniformly was found to date from a decrease in physical activity. Man's appetite, like that of experimental animals, apparently fails to drop off in keeping with a sedentary existence (35).

Other findings elucidated in human studies also bear a striking resemblance to those disclosed in animal experimentation. Obese subjects appear to be far less active than the nonobese in terms of the daily distance traveled as measured by the pedometer (99). The researchers observe that "caloric expenditure due to physical activity is a potentially important and largely neglected factor in human obesity."

Comparison of the food intake and body weights of height-matched individuals grouped according to the amount of physical activity in their lives revealed that, in general, inactivity loomed more important in overweight than the amount of food consumed (61). A series of studies done on children supports this same hypothesis and indicates that habits of inactivity which may lead to obesity, then or later, are often acquired early in life (45, 46).

Recently it has been shown that exercise increases the disappearance rate of unesterified fatty acids and accelerates the disappearance of albumin bound radiopalmitate (30). The fate of the removed unesterified fatty acids is indicated by a reported five-to-six-fold increase in $C14O_2$ excretion during exercise (29). In a somewhat similar study in which one leg of the subjects was exercised while the other was at rest, it was shown that in moderate exercise unesterified fatty acids are extracted from the plasma perfusing the exercising leg (12). Presumably, the unesterified fatty acids are utilized in the muscular tissues and completely oxidized. This may explain indirectly why and how exercise acts to help control weight.

Inactivity Compensation. A relatively recent report of the Council on Foods and Nutrition of the American Medical Association (85) provides a succinct summary of present attitudes toward exercise and weight control. The report associates the gain in weight experienced by many of our population as they grow older with several factors, one of which is termed the "physical activity output."

> The mechanization of life in recent years has had an influence on calorie expenditure. Some people have compensated by using this leisure time for active sports whereas others have not.

This statement reflects the current consensus of nutritionists and medical specialists in the nutrition area on the role of physical activity in weight control. The easily drawn implication is that the American people must learn

to substitute physical recreation for the physical work that used to be a part of daily living. This exchange, however, is not so easily brought about. Although physical recreation may be more enjoyable, it is undertaken on a voluntary basis, while physical work was formerly a required part of living.

Mayer, who probably more than anyone else has helped to gain scientific acceptance of exercise as a proper means of weight control, puts the choice another way: "Adaptation to today's mechanized living, without development of obesity, means that the individual will either have to step up his activity or be mildly or actually hungry all his life" (56).

The only alternative is "creeping overweight" with its attendant greater incidence of degenerative disease and disability, and perhaps even earlier death. This is not to suggest weekend exercise bouts or other strenuous irregular activity for the overweight, poorly conditioned person but rather the purposeful inclusion of optimum physical recreation in everyday living.

Exercise and Cardiovascular Disease

The increasing mortality rate from cardiovascular disease in recent years is a matter of concern to the layman as well as the professional person. Part of the increase is merely apparent due to more accurate diagnosis, and part to the fact that more people are escaping yesterday's killers, such as influenza, pneumonia, tuberculosis, and other communicable disease, to live to the age when degenerative vascular disease begins to take its toll. Most alarming, however, is the increase in mortality from heart and blood vessel diseases among relatively young men.

Among the conditions incriminated as factors in occlusive disease of the coronary arteries, the principal cause of mortality and disability in these individuals, are overweight, faulty diet, emotional stress, cigarette smoking, and lack of suitable exercise. In assessing the possible role of lack of exercise, it is important to consider several variables and other related factors.

Activity Differences within Populations. A number of investigators have attempted to establish the role of exercise in delaying the onset of degenerative vascular disease by comparative studies of the incidence of this disorder in groups whose living habits are otherwise similar but who differ in the amount of daily physical activity.

Such comparisons are difficult to make in animals, since restricting an experimental group or forcing activity may introduce a stress factor. However, post-mortem studies of both mammals and birds at the Philadelphia Zoo have shown significant increases in the incidence of arteriosclerosis with confinement and crowding (89). The researchers attribute the increase to imbalance of adrenal secretion due to inactivity, stress, or both.

One of the earliest investigations of this kind in man was a large-scale review, covering 25 years, of the Reports of the Registrar General for England and Wales (94). The incidence of deaths from coronary disease was found to be definitely related to occupations.

MALE OCCUPATIONS OF HIGHEST AND LOWEST MORTALITY FROM CORONARY DISEASE

Highest		Lowest	
Occupation	SMR	Occupation	SMR
Physicians, surgeons	368	Coal miners	40
Business proprietors	235	Stone miners and quarriers	38
Judges, lawyers	227	Agricultural and gardening trades	32
Clergymen	218	Chemical workers	20

SMR (Standardized mortality ratio) is the percentage ratio of *actual* deaths among men in an occupation at a given age period to the *expected* death rates for all males for that age period.

Conclusions of the study related coronary disease chiefly to genetics, the stress of sustained mental work, and the emotional tensions found in certain occupations. However, examination of the table above reveals that the occupations of highest incidence of coronary disease are also those involving minimal physical activity.

In a more recent somewhat similar survey, the relatively sedentary drivers on London buses were compared with the conductors who are much more active in the performance of their duties on the double-decker vehicles. Bus drivers had significantly more fatal "heart attacks" than the more active conductors and their recovery rate from the "attacks" was significantly poorer.

Similar findings resulted from investigation of the incidence and seriousness of heart attack among postal clerks (sedentary) and their more active postman colleagues. Comparable differences were also found in a follow-up analysis of mortality data for more than 2,000,000 persons in the general population. Invariably a greater incidence of fatal heart attacks occurred in the occupational groups whose work was the most sedentary (75, 76).

The findings of the London studies were supported by subsequent investigation into mortality records in Scotland (77). Almost three times as many fatal heart attacks occurred among sedentary workers as took place in occupations requiring heavy labor. An almost identical ratio, as to incidence, for those engaged in sedentary and hard physical work, was found in an epidemiological study of coronary heart disease in North Dakota, according to a preliminary report (118). The results of a study in the Los Angeles area did not confirm these findings either in terms of the activity of work or amount of physical recreation off the job. (9). However, this investigation was somewhat limited in scope and size of samples.

Using a different approach, Morris and his associates restudied the problem a few years after their first investigation (74). In the later study, pathologists reported on the post-mortem examination of the hearts of some

4000 men whose deaths were not attributed to coronary heart disease. Those in occupations involving heavy labor had significantly fewer scars indicating coronary occlusion during life than those engaged in light work.

Another recent study made in this country in terms of the varying activity in the different jobs of railroad workers has not yet been published (103). Among these workers, clerks (the most sedentary) have a death rate significantly higher than yard workers (moderately active), who in turn have a rate significantly higher than track workers (very active). The differences in death rate noted are accounted for almost entirely by coronary heart disease.

In an analysis of these and similar findings, however, the researchers suggested that if exercise is operative in slowing the development of coronary heart disease, these effects probably relate chiefly to advanced atherosclerosis (106).

A study of death rates according to physical exertion demands of various occupational classes and the cardiac status of the subjects also revealed some interesting results (33). Among those with normal hearts, there was little difference in death rate from one job to another. In men with heart disease, however, the highest death rates were observed among those employed in sedentary or light work, while the lowest rates occurred among those in jobs involving moderate or heavy work. The comparatively small number of cases and deaths prohibited firm conclusions.

A report to the 86th Congress summarizing the epidemiology of arteriosclerosis as it relates to occupation and degree of physical activity states that studies indicate heart disease to be relatively rare in persons engaged in heavy work, intermediate in those involved in moderately active occupations, and highest in those in more sedentary occupations (108). The report also points out that an increasing incidence of heart disease is being observed in countries where improved technology is bringing about decreased expenditure of energy in various occupations.

At present the weight of the evidence obtained from such comparative analyses points strongly to a probable relationship between the incidence of coronary heart disease and the amount of physical activity in daily living. This seems to be true despite bias factors, such as constitutional preference in choice of work and limited populations in some of the studies. The extent to which regular physical recreation will confer the same benefits as the physical activity of work remains to be determined by further research.

Exercise and Blood Cholesterol Levels. The level and particle size of certain blood fats, particularly those related to cholesterol, appear to be associated with atherosclerosis (narrowing of arteries due to fatty deposits upon their walls and accompanying degeneration) in a manner as yet undetermined. Coronary artery thrombosis with resultant occlusion occurs more commonly where severe degrees of atherosclerosis in the coronaries are present.

Atherosclerosis has been produced experimentally in at least five species of animals—rabbit, chick, dog, monkey, and rat—but in each case, only with the use of some procedure to raise appreciably the serum (blood) cholesterol (97).

The apparent association of high total cholesterol level and atherogenesis in many cases suggests the desirability of attempting to keep the total serum cholesterol level within limits generally considered normal (100-250 mg. %). A number of factors, including exercise, are thought to exert an influence on the cholesterol level and the onset of atherosclerosis. If the role of exercise in maintaining normal levels were proved to be significant, this would in turn demonstrate a valuable contribution to the maintenance of health.

In experiments with rabbits, a marked decrease of blood cholesterol following strenuous treadmill exercise has been reported (78). A significant diminution was also found in the deposition of atheroma in the aortas of rabbits given regular exercise as contrasted with sedentary animals (51). The fact that dogs reacted in opposite fashion to similar activity showing higher cholesterol levels and more advanced atherosclerosis (62) introduces the possibility of species differences.

Chickens placed on diets productive of high serum cholesterol levels and subjected to exercise maintained lower levels than birds allowed to remain inactive (116, 117). When mice were employed as experimental animals, they did not evidence similar reduction in blood cholesterol level with physical activity (82). However, the activity involved was swimming, which may have introduced a stress factor.

Studies now under way in which an "atherogenic" diet of doubled amount is being employed in an attempt to isolate more clearly the preventive effects of exercise (115) and others which seek additional information about its influence on cholesterol levels in relation to body composition of experimental animals (68) may provide new and helpful data.

In man, earlier experiments (1955 reports) on exercise and blood cholesterol levels both in France and in this country indicated that when exercise was strenuous enough to bring about weight loss in obese subjects, the cholesterol levels were also decreased (13, 52). Even with excess caloric intake, when exercise was vigorous enough to burn up the extra calories, both the cholesterol level and the weight remained relatively constant.

Subsequent studies have tended to confirm these findings (47, 71, 79) although in one study (105) no significant reduction in serum cholesterol resulted. Reductions brought about by physical activity were the result of hard exercise of considerable duration (34, 84).

Preliminary reports concerning interesting research now going on lend further support to the hypothesis that physical activity can desirably affect serum cholesterol levels (26, 64). The tentative conclusion can be drawn that exercise is one of the several significant factors involved in maintaining blood cholesterol levels within limits generally considered normal.

Exercise and Clotting Time of Blood. It has been suggested that a shortening of blood clotting time is associated with a greater tendency to fibrin formation and atheroma of the arterial walls. It has also been suggested that a high intake of fat and low level of physical activity can adversely influence or shorten clotting time.

Recent experiments have indicated that blood coagulation times can be significantly lengthened, cholesterol levels lowered, and the progress of atherogenesis arrested by exercise in cholesterol-fed cockerels (113). This was true, however, only after stress factors in exercise, which had produced a negative effect in other studies (10) concerned with the effect of exercise on lipid metabolism, had been eliminated. It has been demonstrated that stress can augment the degree of experimental atherosclerosis in animals (50).

Only a few studies of the effect of exercise on the coagulation rate of blood in man and its possible relationships to atherosclerosis appear in the literature. Severe exercise and exercise involving stress were found to bring about a reduction in time of coagulation (95, 111).

In more recent experimental work concerned with regular exercise not involving stress, the expected reduction of clotting time following a high-fat meal was not realized. The reduction after the high-fat meal was inversely proportional to the amount of physical activity of the subjects studied (63).

Obviously the experimental evidence as to the effects of exercise on blood coagulation rate is at present too limited to permit definitive conclusions. Recent studies of both animals and man suggest that exercise, apart from emotional stress, may significantly inhibit the reduction in clotting time that ordinarily occurs following the ingestion of high-fat meals. Further studies, particularly in relation to the effects of long-term regular conditioning programs on blood coagulability, are indicated.

Other Possible Contributions of Exercise. In a recapitulation of the health records of former football players, the most interesting finding concerned the amount of exercise taken habitually during the lifetime of these men. "Those in the coronary group engaged in less vigorous exercise than did the others, and no individual in the study who maintained a heavy exercise program happened to develop coronary heart disease" (85). Admittedly the samples were small, but interestingly they did not manifest any other wide diversity in living practices.

In experimental work with dogs, it has been found that exercise will help to speed up the development of collateral (secondary or accessory) circulation when there is constriction or narrowing of the coronary arteries (24). There is considerable evidence to indicate that identical mechanisms probably operate to develop collateral vessels in both man and the dog. It is suggested that since this onset of coronary disease is not recognizable, it would be a wise precaution for middle-aged human beings to exercise judiciously.

This advice can be carried a step further in terms of much younger persons. A high proportion of even the younger men killed in the Korean war evi-

denced the beginning signs of atherosclerosis on post-mortem (25). The same condition prevailed among Air Force personnel killed in accidents in recent years (32).

Accumulating evidence strongly suggests a relationship between the level of physical activity and the health of the cardiovascular system. The mechanisms of this association are not yet clear but probably relate to the maintenance of serum cholesterol levels within desirable limits, the inhibition of the blood coagulation rate, and possibly the maintenance of a better blood supply for the heart muscle. In subsequent human studies, a special effort should be made to control stress factors, dietary practices, and constitutional disposition in relation to activity more completely, so as to isolate the role of exercise. Logically, physical recreation could supply the apparent benefits of physical work, but this premise has not been proved.

Exercise, Aging, and Longevity

Whether exercise can help to inhibit the aging process and its effect, if any, on length of life have been the subject of considerable conjecture and some investigation. It has been well established that heredity is an important factor in the appearance of the evidences of aging as well as in longevity. The question is, therefore, whether exercise can help to extend the natural heritage of the individual.

Exercise and Aging. One of the common so-called stigmata of aging is obesity, with an accompanying loss of optimum physical appearance and proportions. The relation of overweight to exercise has been summarized. Lately some evidence is appearing to indicate that improved muscle tone, a better response to the demands of living, and a more desirable appearance can be preserved by regular, prescribed exercise (16).

Other studies also indicate that in middle age and beyond, exercise can be a useful means of preserving more youthful body contours, retaining functional organic reserves, and maintaining the general resiliency of the body (17, 79, 95).

On the opposite side of the picture, it has been shown that extended bed rest results in weakness with loss of tone and eventual atrophy of muscles (3, 104). The inference can be drawn that sedentary living, lying perhaps halfway between bed rest and a reasonably active life, offers little beyond mere existence. Regular exercise, on the other hand, may provide a means of strengthening the adaptive mechanisms of the body and consequently increasing the survival potential.

Observations concerning the youthful physiological responses and appearance of older athletes who have maintained conditioning programs into later life have resulted in attempts to study systematically groups of people who have kept up their activity into old age in comparison with others who have taken little or no exercise (8, 48).

As has been indicated earlier, the superior fitness of those who engage in regular physical activity is expressed in one way by delay in the onset of the degenerative processes ordinarily associated with aging. Since genetic factors apparently are also influential in this regard, further research to clarify the importance of these two variables is clearly necessary.

Healthy old age, it appears, requires few restrictions in relation to rational physical activity, particularly for those who have exercised regularly. In comprehensive comparative studies of the responses of boys and men of various ages to exercise, it has been shown that while certain physiological capacities are impaired by aging, there still remains sufficient reserve in healthy elderly persons to cope with reasonable activity (5, 37, 38, 92). In fact the older subjects make up in part for physiological limitations by economy of movement and mechanical efficiency.

A recent report of the Michigan State Medical Society, setting forth the consensus of a scientific symposium on aging presented by physicians, physiologists, nutritionists, and physical educators, concluded:

> All opinion sampled testifies to the benefit of physical education and physical exercise in the preservation of health in the aging group. Moreover, it is definitely indicated that the so-called physical stigmata of aging might be postponed a number of years by the institution of planned physical education and exercise (67).

In a similar vein, the Committee on Aging of the American Medical Association in a series of articles on the health aspects of aging has given considerable attention to the role of exercise in aging (14). The benefits of exercise are listed as (a) the maintenance of good muscle tone including that of the heart itself; (b) the milking action of exercising muscles on the veins as this assists in the venous return of blood; (c) the improvement of digestion, probably indirectly, through relief of nervous tension; (d) the favorable effect of exercise in helping to control obesity; and (e) the deepening of respiration which comes with exercise, as this improves gaseous exchange and the state of the lung tissue itself. These suggested benefits are obviously as important to the health of older persons as to younger people.

More research is definitely needed to supplement findings now available on exercise and aging before definite conclusions can be drawn. Present indications are that regular exercise does help to preserve health into later life and perhaps even to postpone death.

Exercise and Longevity. Since the lifetimes of some experimental animals are relatively short, comparative studies of the longevity of regularly exercised and sedentary littermates could be productive of useful results. However, such studies do not appear to have been reported, although a pilot study of this type is now in progress at Emory University in Georgia (100).

Another method of making animal studies relating to longevity involves the recording of mortality statistics for animals held in captivity and the comparison of the average age at death of those in close confinement with that of animals having more freedom and consequently more activity. This

has been done, as indicated earlier, at the Philadelphia Zoo, where crowded conditions have resulted in increased confinement in recent years. Findings were that the crowding resulted in a decrease in average age at death of animals and birds, probably due to a combination of stress and inactivity (89). Under the conditions of this study, it is difficult, of course, to differentiate between these two factors and some others that may have been involved.

A number of investigations of a similar type have been done in man. Several of these have compared the longevity of athletes with that of the general population; in general this type of comparison has indicated that the athlete lives somewhat longer than the rest of the population. The earliest of these (1873 and 1904), dealing with former oarsmen, gave the athletes an edge of more than two years in longevity over the insurance populations with which they were compared (66, 72).

Later, comparable studies covering former athletes who had earned their Y at Yale University in a variety of sports (2) and cricket players from Oxford, Cambridge, and county teams in England (42), gave similar advantages in longevity to the athletes when they were compared with the general population. Studies of other former college letter winners in two or more sports (21) and of high school basketball players (112) and follow-up studies of oarsmen in England (39) and Australia (15) again yielded similar results. All of these studies are subject to serious criticism, however, in that the athletes were compared with general insurance populations rather than with their own college or group population. There is the possibility that college students as a whole might have a higher life expectancy than the general population.

Recognition of the probable validity of this criticism led other investigators to make additional studies and some of the original investigators to restudy the problem by comparing the longevity of athletes with that of nonathletes who attended the same institutions or belonged to the same population group. Among the earliest of these was another study of former Yale athletes in which the longevity of Y men was compared with that of other former students (36). The ratio of actual to expected deaths was somewhat higher among athletes than that for the controls, but these results are inconclusive because of the limited number of letter men in the study. The same thing can probably be said in respect to a study of army officers in which the longevity of letter winners at West Point was compared to that of the rest of the group (90). Here the findings were that letter men lived somewhat longer on the average.

Carefully controlled and comprehensive studies have been done, however, in which athletes were compared with indigenous population groups (19, 22, 70, 93). The findings were that athletes live about the same number of years on the average as do their contemporaries within a like population. A second conclusion drawn from the results of these studies was that college students live, on the average, about two years longer than the general insurance population and thus, from the standpoint of longevity, are a select group.

Studies like those above were presumably to discover whether those who participated in vigorous activity would survive longer on the average than their less active fellows. But there is no assurance that the athlete will continue his activity after college years. Unless this aspect of the matter is followed up, the findings relate only to the possible effect on longevity of vigorous activity in youth.

No reports of large-scale scientific studies of continuing physical recreation throughout life and its possible effects on longevity through comparison with sedentary control groups from among a similar population were located in the literature. However, in some of the longevity studies of athletes and nonathletes, efforts were made to trace the amount of physical activity in the after-college lives of the subjects (66, 69). In other studies investigators have delved into this matter but in a somewhat limited way (107). The results are inconclusive because of relatively small samples and the difficulty of evaluating the extent of activity in retrospect.

In well-controlled longevity studies, there was no significant difference between former athletes and nonathletes in the causes of death. However, there does appear to be a difference in the number of violent deaths, with these running considerably higher, in the aggregate, among former athletes.

The results of the several studies taken together indicate that, barring accidents, athletes probably live slightly longer on the average than nonathletes in the same population. However, the apparent difference cannot be linked to physical activity without further research to carefully trace the post-college exercise practices of the two groups.

Exercise and Capacity to Meet Emergencies

The base line of normal activity is extremely variable from individual to individual. A man with a sedentary occupation, such as watchmaker, whose only exercise is the small amount necessary in walking, stair-climbing, and other daily activities, lies at the lower end of the scale. Opposite is the professional athlete who maintains himself by strenuous exercise in a constant state of fitness. Yet the vagaries of life are such that the man of sedentary habits may unexpectedly be called upon to perform physical actions that require strength, endurance, speed, and coordination under conditions that demand maximum adaptability to an unfavorable environment. The daily newspapers are replete with instances of failure to meet these emergency conditions satisfactorily, with serious injury or even death the outcome.

Among the many typical situations requiring unusual expenditures of energy and adaptive ability that may be encountered in the midst of our busy civilization are the following:

1. A short run at maximum speed from a standing start to escape an oncoming vehicle, to catch a public conveyance, or in pursuit or as the pursued.
2. A fall into water in heavy clothing, perhaps with an associated injury, or in a struggle with another in the water or in a flood.
3. A fall from a height under conditions precluding immediate rescue, as in an isolated place, a shaftway or a well, and with associated injury.

4. Entrapment or entombment in a burning house, in a collapsed dwelling, or under the earth.
5. Injury and containment in a motor vehicle, train, or airship, and delayed rescue.
6. Exposure in wilderness areas, without protective clothing, equipment, or adequate shelter.
7. Unusually heavy and prolonged physical activity such as might be required by the circumstances resulting from a natural catastrophe.

Each of these situations may take place under adverse climatic conditions of extreme heat, cold, humidity, aridity; in rain, sleet, or snow. The physically fit person is more likely to cope with such situations successfully than is the person whose body has not been properly conditioned by exericse. The reason for this may be derived from the following considerations.

The ability to respond quickly and effectively to the emergency situation depends primarily on the efficiency and reserve capacity of the cardiovascular systems. According to Raab, myocardial oxidative metabolism and energetic efficiency are dominated by the interplay of the adrenosympathetic catecholamines and vagal acetylcholine. Sympathetic adrenergic preponderance constitutes a threat to myocardial function and structural integrity. Cholinergic vagal preponderance improves the oxygen economy of the heart muscle and increases efficiency (87, 88). Systematically trained sportsmen display, as a rule, highly developed vagal tone.

Unusually powerful contractility has been observed in the heart of the athlete, which becomese larger in the course of athletic training due to muscular hypertrophy as well as dilatation (7, 91). A relative degree of improvement in heart function may be expected by those who participate in planned conditioning and physical recreation programs on a regular basis.

Studies of the intermediate cardiac metabolism in nonexercised and exercised rats show that the latter maintain superior function as evidenced by associated biochemical relationships (96).

Hypertrophy of muscle occurs wherever the work load of the muscle is increased sufficiently over a long period of time. Morpurgo (73) was the first to show, in 1897, that hypertrophy of the individual fiber is the uniform muscular response to increased mechanical tension.

Contrary to the situation in the pathologically hypertrophied heart where the existing capillaries are simply pushed farther apart in the muscle tissue, the capillary network of the athlete's heart becomes unusually abundant (83). It has been demonstrated, also, that the development of collateral circulation with a consequent improvement in blood supply and nourishment of the heart muscles can be accelerated by planned conditioning (24).

The long-term functional efficiency of the cardiovascular system is impaired by the development of arteriosclerosis. The relationship between high levels of total serum cholesterol and arteriosclerosis is as yet uncertain in spite of the volume of research that has been devoted to this subject. As has been indicated earlier, however, total serum cholesterol levels may be kept within normal limits in persons consuming a high-fat diet if they have regular, vigorous exercise (47, 71, 102).

The ability of the intact cardiovascular system to respond rapidly to the emergency or to demonstrate endurance in prolonged and unusual stress depends also on the existence of adequate reserve capacity in the respiratory system. The regular deep breathing with maximal expiration that results from regular physical exercise results in a slower pulse rate and an improvement in the efficiency of the pulmonary circulation and, therefore, increased work capacity. Concentration of oxygen in the alveolar air is increased during periods of maximum expiration. Oxygen debt is smaller and accumulation of lactic acid in the blood is roughly 20 percent less under these conditions of exercise. The effect of regular, intensive physical training is to establish these patterns of function in the body on a basis that carries over from the period of exercise (49, 54).

Exposure to severe heat or cold under conditions of physical stress may result in abnormally high and abnormally low body temperatures, respectively, in the untrained subject. Muscle work increases the body temperature to a level that is roughly proportionate to the severity of the exercise and the environmental temperature (43). Training by physical exercise enables the body to regulate its internal temperature more efficiently so that work output is improved and overheating and abnormal cooling are prevented (1, 6). The untrained person will die very quickly from his own exertions if cast away in the desert or in Arctic wilderness, while the physically fit may survive to reach shelter, walk out, or be rescued.

The ability of the individual to perform heavy work for prolonged periods or to survive exposure to severe cold, where heavy demands are made on muscles in the act of shivering, can be measured, according to Balke (4), in terms of what he calls the "metabolic potential." This he measures in "METS," the number of times the individual can increase his basal metabolic rate. This in turn depends on increasing the maximum oxygen intake and building up storage of tissue glycogen. Both of these capacities are greatly increased by hard training; since they seem to increase *pari passu*, one can be taken as an index of the others. Continuance of exercise will maintain these capacities at a high level.

Ability to survive the emergency stress situation may also depend on excellent neuromuscular coordination. Physical training exerts a favorable effect on autonomic nervous balance, increases reaction to light and sound stimuli, and produces kinesthetic nervous adjustments that are long-lasting. Eyesight is improved as evidenced by the response to flicker fusion frequency tests. Most important of all, muscle strength and endurance that are improved greatly by physical exercise are well maintained over long periods of time when once well established (18).

Evidence that there are also favorable benefits to certain body processes is also becoming available. Recent research indicates that intestinal mobility is increased by exercise (110), which in turn could bring about improved digestive action and capability.

In summarizing an extensive review of the literature relating to the chronic (training) effects of exercise, Steinhaus (98) suggests three chief results: (a) gain in strength, (b) improvement of endurance, and (c) perfection of movement. Each effect is so thoroughly documented as to leave no doubt that the changes do occur.

The relationship of these training effects to the improvement of the individual's capacity to meet emergencies effectively is obvious. Insofar as such improvement may help to ward off disease, disability, and death that can result from failure to meet emergencies successfully, it also has value for physical health.

Summary

Pertinent clinical observations and research studies concerned with the contributions of physical activity to physical health have been reviewed and appraised. Contributions, as benefits to health, were carefully distinguished from physiological effects. Also for purposes of this review, the terms *exercise* and *physical activity* have been considered synonymous.

Discussion has been categorically divided into four areas of consideration: Exercise and Weight Control; Exercise and Cardiovascular Disease; Exercise, Aging, and Longevity; and Exercise and the Capacity To Meet Emergencies. It is recognized that some overlapping is inevitable among these categories or among other possible divisions.

The following conclusions appear to be justified as a result of this analysis and assessment of clinical observations and research studies.

1. Regular exercise can play a significant role in the prevention of obesity and thereby indirectly influence the greater incidence of degenerative disease and shortened life span associated with this condition.

2. A high level of physical activity throughout life appears to be one of the factors that act to inhibit the vascular degeneration characteristic of coronary heart disease, the most common cause of death among cardiovascular disorders.

3. Regular exercise assists in preserving the physical characteristics of youth and delaying the onset of the stigmata of aging and probably exerts a favorable influence upon longevity.

4. Conditioning the body through regular exercise enables the individual to meet emergencies more effectively and so serves, in turn, to preserve health and to avoid disability and perhaps even death.

Each of these benefits is valauble in itself; together they amount to a significant contribution to physical health. What has always been suspected is beginning to be scientifically demonstrated. Exercise may still be considered good "medicine."

> Better to hunt in fields, for health unbought,
> Than fee the doctor for a nauseous draught.
> The wise, for cure, on exercise depend;
> God never made his work for man to mend.—*John Dryden*

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The Contributions of Physical Activity to Social Development

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WE SOCIALIZE OUR PUPILS or contribute to their social learnings when they learn the ways of the group, become functioning members of it, act according to its standards, accept its rules, and in turn become accepted by the group. We socialize youth by helping them acquire social experiences, social habits, and social relationships. Our interest is in the development of the social phases of personality, attitudes, and values by means of games, sports, and related activities.

Thoughtful people agree that emotional and social learnings are important, for real education is an emotional and social as well as an intellectual experience, and that there must be an effective curriculum for personal-social education that parallels and often intertwines the academic curriculum. The direction for improving social education demands the utilization of insights and studies from many disciplines from which health education, physical education, and recreation draw their basic principles. We must, therefore, look not only to the research and thoughtful study of specialists in the areas of biology, psychology, psychiatry, and medicine, but also to the social sciences of sociology, cultural anthropology, and social psychology.

We can be scientific in our respective fields to the extent that we employ intelligent and persistent endeavors to revise current beliefs, weed out error, improve upon the accuracy of our beliefs, and search for the significant relationships between facts drawn from the several disciplines previously mentioned. The *method*, not the content, defines the body of knowledge as a science. Physical education, health education, and recreation become scientific to the extent to which we apply the scientific method to the phenomena that are their subject matter.

There must be some cause and effect laws in the way human beings behave just as there are cause and effect laws in the way steel, rubber, or the atom behaves. Where do we look for these principles? The behavioral sciences provide possibilities by honest, exhaustive, intelligent, interdisciplinary searching for facts and their meaning or implications with reference to any given problem in our field.

In the area of psychosocial development it is exceedingly difficult to establish functional relationships between numerous variables involved. This makes the task of validating causative explanations of individual behavior a terrifically challenging and difficult one.

It is hoped that the numerous studies drawn from the several disciplines attempting to show the effects of physical activity upon the personal and social adjustment of people will be examined with careful scrutiny and realization of the paucity of significant definitive research which bears on this important problem of the social dividends of education.

Social Development in a Culture

Culture consists of the things that we have learned to do, to make, to believe, to value, and to enjoy in our lifetime. Our culture expresses the basic values of our society. The forces which interact on the playing fields, in the gymnasium, and elsewhere provide for children a steady flow of motivations and feelings which gradually shape the personality. In the sense that we as teachers have a part in controlling or influencing to some extent these factors in our culture, we become guardians and developers of personality by influencing the dominant attitudes and goals of that part of our culture related to games, sports, and recreation in general.

Four investigators related interest and participation in sports to social values and learning in children.

Thrasher (97), in the study of city boys' gangs, indicated that physical prowess is an important factor in group leadership, but not essential. Boys physically deficient received positions of leadership by traits of "daring, decisiveness, and brains."

Hawkes (46), using an inventory entitled "making choices," found that boys (grades 4-6) placed friendship, excitement and recreation, and family life at the top of the rank order and valued least privacy, power and control, and recognition. Girls (same grades) valued friendship, family life and excitement, and recreation in descending order. At the base of the rank order they placed physical freedom, recognition, and power and control.

Dennis (28), comparing American, Armenian, Arab, and Jewish children in Lebanon, found that American children were rewarded with praise for performing in sports and games three times more frequently than were the Arab and Jewish groups. He pointed out that the kinds of behavior being rewarded played a role in the socialization of the child.

Broer and Holland (16) found that college women recognized the social values of physical education. Of some 1115 freshmen and sophomore women who responded to an interests and needs questionnaire, 83.5 percent checked "to have fun," 56 percent "to make new friends," 42.3 percent "to learn to control myself and be a good sport," 40 percent "to get along with and understand other people," 22.2 percent "to feel that I belong to a group." Coeducational class activities which had a strong social and dating element headed the list.

Social Psychology

It is well known that participants of a culture or in a group take on the existing values or norms of the group. A democratic "climate" produces

democratic values, and a sportsmanlike "climate" produces attitudes of sportsmanship. We perceive these situations in terms of the norms we bring from the group situation. We deal here with the role of suggestion in the formation of attitudes.

Using parent rating and child behavior rating scales, Baldwin (4) found that democratically raised children were more active, were more extroverted (friendly and hostile), and were favored in their group. They rated high in intellectual curiosity, originality, and constructiveness. The variable "indulgence" seemed to produce the opposite effects of democracy.

Sherif (84) found that individual subjects tended to be strongly influenced by others in the group, the degree of influence being effected by the prestige and leadership qualities of certain group members. His findings have implications for values stressed in games and sports, for major attitudes are derived from groups to which we relate ourselves or of which we regard ourselves as members.

Dunker (30) found it feasible to influence nursery school children's food preferences through social suggestion. After determining the children's preferences and their tendency to imitate others, stories were told to present certain foods in an attractive light and other foods in an unattractive light. Sixty-seven percent of the children in the experimental group chose the food presented as attractive against only 13 percent of the children in the control group. Implications may be drawn for seeking character education outcomes through play situations.

Symonds (94), studying normal adolescent boys and girls, concluded that the greatest need of these adolescents was opportunity for social participation and that the greatest personality handicap was social isolation. Physical education and recreation activities were indicated.

Kight (52), Stone (91), and Lifshitz and Sakoda (62) have drawn conclusions concerning camping experiences in the changing of social attitudes and in meeting social and emotional needs of children and adolescents.

School and Teacher as Social Forces

The school represents a social structure and system of its own—of students, teachers, administrators, and service personnel. In the various social subgroups which are constantly forming and reforming, pupils get to fill social roles in many different groups, such as classes, clubs, athletic teams, orchestras, student councils, and a host of others. The experiences in these various groups provide the social and psychological settings and conditions for the development of many aspects of social learning—knowledges, attitudes, skills, and values. The teacher and administrator must find ways in which all participants relate themselves to one another so that new social learnings result not only in greater social integration and efficiency but also in individual satisfaction of needs.

Several studies highlight the influence of the classroom climate. Lewin and his associates (60) found that autocratic situations produced tension, in-

dividual hostility, and less stability in the group structure whereas in the democratic situation there was greater constructiveness and a stronger feeling of group property and group goals.

Pressey and Hanna (75) compared two classes, one operated in the traditional manner, the other in a more or less permissive manner which encouraged social interaction. Students in the social interaction class knew the names of more of their classmates than in the traditional class. Obviously, proper social atmosphere is essential for social contracts.

Nedelsky (70) indicated that the child's first social world is his family; he then shifts to a world in which his orientation grows out of being a part of a group of other children whom he accepts as equals. The school then becomes the social system which is an important setting in which children relate to one another.

Swensen and Rhulman (93), in analyzing questionnaire responses from 1217 university sophomore men and women concerning many aspects of their extracurricular activities, found that the four chief reasons for participating were (in rank order) relaxation, working with people, professional reasons, and opportunities for service. The highest percentage of participation in campus activities was in social living groups (dormitories, fraternities, etc.). Athletic events were the most popular spectator-type activities.

Todd (99), in a sociometric study on the senior high school level, demonstrated the value of the democratic method of physical education class management by objective data showing greatly increased acquaintanceship and significant decrease in the number of unpopular and unwanted girls during a one-semester experimental period. Anonymous questionnaires revealed that the pupils found the sociometrically selected squads more enjoyable and efficient than any other grouping method they had ever experienced.

McGuire and Clark (65) reported upon two alternative indexes of peer status that have been recently developed. The two forms seem to approximate essential aspects of the level of acceptance of subjects in classroom groupings and in age-mate societies. It appears that level of acceptance could be a variable for distinguishing and identifying individuals and subgroups in a population for further study .

Two studies report the social influence of the teacher. Leeds (59) found that the personality characteristics of the teacher affect the social and emotional development and adjustment of children. Comments as to why pupils liked or did not like certain teachers indicated that affective, personal, and human factors provided the basis for differentiating between well-liked and disliked teachers. Witty (113) analyzed 12,000 letters from children and adolescents describing "the teacher who helped me most." All teacher personality attributes which tended to bolster the security and self-esteem of the pupils were valued highly. Praise and recognition, kindliness, fairness, sense of humor, interest in pupil's problems, and similar qualities were prominent, and these attributes markedly affected the personality development of pupils.

Social Development

Much social interaction centers around physical skill. The child lacking motor skills is often barred or not accepted in social participation. Human personality cannot be developed apart from the social group and since our children are destined to live in a highly organized social order, the physical activities of children and youth should be used progressively from kindergarten through high school to develop social learnings and a gradual intensification of social consciousness.

The social implications of play and sports are revealed in several studies. Foehrenbach (35), when inquiring into the social motives operating to make high school girls participate in after-school sports, found that "going with the crowd" and "imitation of older girls" were prominent in the thinking of junior high school girls, while "making new friends" was a stronger motive for senior high school girls. "Fear of failure to do well" kept about one-sixth of the junior high girls from participating, and the fact that they had no friends who were participating restrained one in ten.

Bunker (17) studied 50 male college students active in physical education and sports and 50 who tended to be inactive in these activities. Histories indicated that participation in team games by the "actives" was consistently greater through the upper grades than for the "inactives." While 64 percent of the actives reported that the greater part of their daily play as children was in neighborhood groups, only 36 percent of the inactives so reported. Bunker concluded that the bases for active participation must be laid in the elementary grades.

Shugart (85), while a psychiatric case worker in the receiving ward of a large neuropsychiatric service in a naval hospital, invariably found histories of meager play experiences in men being referred to the hospital. Patients experienced lack of interest in play as children, and deficiences therein were evident in both quantity and quality. Further study, elsewhere, of the play histories of 60 psychotic children showed that these children had suffered serious play deficiencies which assumed characteristic forms of expressi[illegible].

Studies of the holding power of secondary schools have revealed that ext[illegible]-curricular activities are important means of keeping students in school. Thomas (96) studied high school drop-outs and discovered "that not one person who dropped out before completing the third year had engaged in even one activity, and that 89 percent of those who finished, had." Since intramural and interscholastic athletics are administered as student activities in practically all high schools, it can be seen that few drop-outs participated in sports activities.

Gough (38) used four high school senior classes in his study. Students who had a higher number of extracurricular activities seemed to be characterized as: (a) frank, unpretentious; (b) self-disciplined, but tolerant of others; (c) broader cultural and intellectual interests; (d) identification with and acceptance by the group; (e) possessed effective social skills; and (f) optimistic, with higher levels of drive and energy.

Wells (110) administered a 38-item battery of physical fitness tests and Cattell's 16 Personality Factor Inventory to 80 male college students. Dynamic strength related negatively to personality traits described as emotional, tense, and withdrawn; and positively with traits described as being less anxious, less emotional, more poised, and less unsure. Various body measurement variables were found to relate significantly to many personality traits.

Comparing academically successful and unsuccessful children, Volberding (105) found that the child considered most likely to succeed is more intelligent, better adjusted socially and personally, more interested in active play, prefers play in competitive groups, attends movies less often, and listens to radio more frequently.

Latham (57) classified 837 junior high school boys according to level of sexual maturity. They were classified by their teachers, also, into three leadership categories—elective, appointive, and athletic. Athletic leaders were found to be sexually more mature than their contemporaries who led in nonathletic activities. None of the other categories of leaders showed clear discrimination of the mature from immature boys.

Jones and Bayley (50, 51) reported that late maturing boys ranked relatively well until the middle of junior high school in social behavior and related personal attributes. Then they tended to drop to a lower level. Early maturing boys became student leaders in high school. Boys maturing late were mostly below average in Espenschade's test of motor ability; early maturers were unusually large and superior in strength and skill.

Duffy (29) studied 16 nursery school children, age 2 years, 11 months to 3 years, 10 months. His observations suggested a possible correlation between muscle tension and various aspects of behavior, such as number of physical contacts in free play, number of words used, degree of restlessness, and degree of inattention.

Resnick (79) studied the relation of high school grades to satisfactory adjustment as judged by scores on several standardized inventories and found that pupils earning the higher grades also secured the highest mean satisfactory adjustment scores. In general, categories related to adjustment in relation to other pupils, to social competency, social participation, satisfying work, recreation and interpersonal skills were significantly in favor of the student with higher honor point ratios.

Reaney (78) tested more than 600 boys and girls on their ability to play certain games (they were also found to be leaders of these games). It was found that the children who were best at playing games were also superior in intelligence and general ability.

From a larger group of normal children, Rarick and McKee (77) selected for investigation 20 third graders. Ten had a high level of motor achievement and the other 10 a low of motor achievement. Though a small number of cases were observed, those children who attained a high level of motor proficiency tended to be more frequently well adjusted in school and

personal relationships. Also they appeared to have fewer irregularities and difficulties in infancy and early childhood.

Partridge (73) studied factors of leadership in six different Boy Scout troops totaling 226 boys by using a "five-man-to-man" plan of rating. He found that outstanding leaders excelled others in age, intelligence, athletic ability, scout rank, scout tenure, and physique.

Betz (7) found low but significant relationships between several physical fitness test variables of adult men participating in an afternoon adult physical fitness class and certain personality traits as determined by Catell's 16 Personality Factor Inventory items.

Antisocial Behavior

Children's insecurities and frustrations show up directly or symbolically in their free play. The aggressive, destructive, unsocial, or antisocial attitudes are acted out in play. As professionally mature physical educators, health educators, and recreation specialists we must try to decipher the real meaning of these activities as sensitive indicators of personality development. We must try to structure play situations that will facilitate release and expression of impulses, feelings, and fantasies. Games and sports often become substitute responses which redirect behavior and satisfactorily reduce the original instigation by satisfying emotional and social needs.

Frank (36) states:

> Sometimes a child who is outwardly apathetic or seemingly withdrawn may, in a congenial and encouraging play situation, emerge with increasingly spontaneous participation, as if waiting for such a favorable opportunity to escape from his own self-imposed restriction. Similarly, an aggressive, destructive child in a play situation offering little opportunity or provocation may discover new ways of relating himself to others through more cooperative play. Children, and especially those "withdrawn" and those overaggressive, may need to translate their private world and feelings into play situations, to make these more or less "objective" outside themselves, so they can deal with them, and begin to alter and revise them toward the patterns of the consensual world.

Hambridge (42) illustrates how structured play therapy enables child and therapist to bring energy to bear where it will count. The therapist acts to focus attention, to stimulate further activity, to give approval, to gain information, to interpret, or to set limits. The structured play situation is used as a stimulus to facilitate the independent, creative free play of the child in treatment.

In tracing the evolution of play therapy, Lebo (58) concludes that if play therapy had developed solely from the theoretical explanations of play it would be used to educate children to play properly.

Bernstein (6) asserts that play is a natural means of expression for the child and can be clinically useful in diagnosis, therapy, and research. Play may diminish anxiety in children and be helpful in evaluating the need for psychiatric help.

Cox (27), in studying sociometric status and individual adjustment before and after play therapy, found that sociometric status was shown to be an

effective index of adjustment for a group of 52 orphans, aged 5 to 13 years. The findings supported the theory that the sociometric status is a sensitive and valid index of behavioral change.

Chittenden (21) used play situations as a means of helping children get a better understanding of their own problems and as a means of finding whether they gained in understanding. Play was used also as a means of direct teaching of manners and techniques that would help children to avoid quarrels.

Shaw (83) found that an inconsistent or conflicting environment retards the development of socially sanctioned behavior. He showed quite dramatically the influence of the group, or small segment of society and its mores, upon the attitude and behavior of individuals.

Wattenberg (108) noted that in any group of full-fledged delinquents, the first signs of behavior difficulties appear in later childhood, often before the age of ten. For eleven year olds, poor school performance and gang activities are strongly related. Frustrations met in school may have led to hostile feelings which were vented in destruction of property or fighting. The author suggests that for those who failed in efforts to earn social recognition (in sports or scholarship), daring deeds of theft and bravado may have been a compensation.

Thomas (95) described the experimental use of the summer camp as part of a remedial program for juvenile delinquents.

Personal-Social Adjustment

Adjustment is the dynamic process by which organisms meet their needs. Physical education and related activities satisfy many of these needs by siphoning off dammed-up tensions in wholesome and socially acceptable ways. If satisfied in opposite ways, neurotic or delinquent behavior may be the result. Studies reveal that socially well-adjusted persons tend to be more successful in athletics, physical fitness, and physical education activities than are persons who are less well adjusted socially.

Jones (49), Hardy (44), and Wenger (111) found some relationship between muscular function and social adjustment. In Jones' study, subjects with high strength scores were rated high in popularity and social prestige and were well adjusted, whereas subjects with low strength scores had social difficulties, inferiority feelings, and personality maladjustment. Hardy found substantial positive correlations between being esteemed by one's classmates and leadership, health, cooperation, I.Q., and E.Q., and between general behavior traits and school attitudes, muscular strength, and physical achievement. Wenger found positive correlations which confirmed the hypothesis that individual differences in characteristic level of muscular tension in skeletal musculature are positively related to differences in (a) frequency of overt muscular activity, (b) speed of movement, (c) emotional behavior and instability of response, (d) aggressiveness, and (e) irritability.

Reynolds (80) found an r of .414 (significant at the 1% level) between scores on the Cowell Personal Distance Ballot and performance on the Purdue Motor Fitness Test, using preadolescent boys as subjects.

Several investigators related social adjustment to physical education performance. Cowell (26) found that social adjustment ratings by teachers and by classmates were positively and significantly related to physical education grades. Breck (14) found correlations ranging from .27 to .90 between choice of friends and skill ratings in activity classes at the University of California, Los Angeles, with those selected as desirable friends having the higher skill ratings.

Using a rating scale for measuring character and personality of persons in physical education classes, Blanchard (9) found that desirable character and personality traits are stimulated by participation in physical education activities. Walsh (106) reported that girls whom others seek as teammates and playing companions seem to be the ones who can perform well in physical activities. Edwards (31) found that performance in the Cowell Athletic Aptitude Test correlated .389 with the Partridge Leadership Ballot, and .371 with the Cowell Personal Distance (Acceptance) Ballot. These correlations, obtained with preadolescent faculty sons, were significant at the 1 percent level of confidence. Also using the Cowell Personal Distance Ballot, Stover (92) found a correlation of .661 between this measure of social acceptance and a 12-item battery of physical achievement.

Another group of studies revealed a relationship between athletic achievement and social adjustment. McKinney (66) found that well-adjusted college students tended to be more athletic, to be more interested in the opposite sex, to participate more in extracurricular activities, and to be of a social nature. Brace (13) found a marked relationship between athletic ability and social status among pupils in grades 6 through 9.

Henry (47) obtained a positive correlation between general athletic ability and favorable attitudes about physical education. The correlation was highest in performances demanding extreme sustained physical exertion and lowest with agility and coordination. Similarily, Biddulph (8) found that students ranking high in athletic achievement showed a significantly greater degree of personal and social adjustment than students ranking low in athletic achievements.

Sperling (88) and Signorella (86) found differences in adjustment between athletes and nonathletes. Sperling found athletes to be more extroverted and ascendant. Signorella found that differences in amount of athletic participation were moderately related to scores on the Cowell Social Adjustment Index.

Zeleny (114) indicated that researchers on leadership are in practically unanimous agreement that leaders are superior to nonleaders in intelligence, scholarship or knowledge, vitality, social adaptability, and athletic ability. Stogdill's (90) summary of leadership research to 1947 found height, weight, energy and health, and especially athletic prowess all associated with leadership.

Reputation of youngsters among their peers has been related to social adjustment by three investigators. Scandrette (81) compared classroom choice status of eighth graders with scores on the California Test of Personality and found that the four components which significantly differentiated the two groups were sense of personal worth, sense of personal freedom, feeling of belonging, and freedom from withdrawing tendencies—all more characteristic of the higher status group. Bonney (10) found, at the sixth-grade level, that among children frequently chosen as playmates there was more "in-group" feeling whereas among children infrequently chosen as playmates there was little acceptance of each other. The rejected children were those considered to be poor playmates.

Tuddenham (104) pointed out that the Reputation Test can be used to reveal problems for social maladjustments much earlier than they are ordinarily detected by adult observers (see also 103). The test diagnoses a child's social adjustment to his peers.

Comparing "fringers" with "active" junior high school boys, Cowell (22) found that fringers were less acceptable, socially, to other boys and girls as compared with actives and were deemed less able to fill school positions.

Studying students' objectives in physical education, Schurr (82) found that 450 freshman high school girls most want to learn to get along with and understand others, to learn to control emotions and be a good sport, and to learn to lose graciously.

Sociometrics

Sociometrics is the study of the patterned relationships between members of groups. Data from such studies enable us to try to understand and adjust those currents of influence that unite or separate the individual members of any group. Health, strength, and physique determine to a great extent what, and especially how well, a child plays. Play skills, in turn, are of major importance in companionship and friendship in the social relationship of children. The physically excellent child has opportunity to lead in games and to learn thereby the very important techniques of leadership and cooperation.

Many studies demonstrate that athletic prowess contributes to social status. Tuddenham (103) applied the Reputation Test to boys and girls in grades 1, 3, and 5. He found that athletic competence, daring, and leadership were sources of prestige for boys, while attractiveness and demure friendliness were important for girls. Tryon (102) found that in middle adolescence social excitement is directed toward the athletic leader or one whose physical, dramatic, social, or intellectual skills give status. McGraw and Tolbert (63) reported a moderately high relationship between sociometric status and athletic ability in almost all groups of junior high school boys in a school in Texas. Kuhlen and Lee (55) studied 700 children in grades 6, 9, and 12. They found that those most acceptable were judged more frequently to be popular, cheerful, happy, enthusiastic, friendly, and those who would enjoy jokes and initiate games and activities.

Todd (100) states that squads chosen on the basis of sociometric information are likely to produce happy, cooperative work and play. Furfey (37) showed that when boys selected chums, physical development had a larger correlation with companionship than did intelligence.

Flowtow (34) and Ondrus (72) both found that members of athletic teams had higher social status than others not able to make the team. Along somewhat the same lines, Marks (67) pointed out that boys with higher sports scores were more sociable than those with lower sports scores. This indicates the social stimulus value of strength and physical ability among adolescent boys. However, at the sixth grade level, Austin and Thompson (3) found that being "skillful in games" was sixteenth on the list of reasons for choosing someone as a friend. In another study of reasons for choosing friends, Williams (112) found that among adolescents such items as "full of fun," "fair and square," "good sport," "athlete," and the like were prominent.

Bretsch (15) further verified that sports participation is related to social skills and activities of adolescents which distinguish socially accepted from unaccepted adolescents.

Wellman (109) found that differences in size, strength, and health seemed to be more important factors in social adjustment than are moderate differences in intelligence. With quite similar findings, Bower (12) pointed out that popularity was unrelated to intelligence, height, home ratings, or school achievement but was significantly related to strength and to physical ability.

Lieb (6) in pre-Nazi Germany found that both boys and girls mentioned physical superiority most frequently as a basis for leadership.

Success in the classroom and social status were investigated in three studies. Gronlund and Whitney (40) showed that sociometric status in the classroom is a fairly reliable index of a pupil's general social acceptability among his peers. Buswell (18) concluded from her study of a classroom of boys and girls in the early and upper grades that in general those who are succeeding in their school work will also be succeeding in their social relationships with their peers. Bonney and Powell (11), studying first graders, found that highly acceptable differed from those sociometrically low by smiling more frequently; engaging in some form of cooperative, voluntary group participation; and making more voluntary contributions to their groups. They were also less likely to be alone during free play or activity periods.

Two investigators studied drop-outs and social status. Kuhlen and Collester (54) found that drop-out was related to such factors as health, unhappiness, and a sense of lack of status. Kuhlen and Bretsch (53) found that those who dropped out of school were less acceptable socially to their classmates and were judged by their classmates to possess traits of personal and social maladjustment.

Activity Preference, Physique, and Personality Characteristics

Studies of personality and somatotyping suggest that there are fundamental types which influence choice of physical activities. These findings have implications for planning physical education on an individual basis.

Thune (98) conducted a study to discover some of the differences in attitudes and personality traits which may exist between weight lifters and other active team sport athletes. He found that training with weights appeals to a certain personality group. Weight lifters tended to be strong and dominant individuals who received more satisfaction in winning an individual championship than being a member of a winning team. They definitely disliked traditional sports.

Hanley (43) reported on the relationship between body type and reputation as measured by a reputation test of the "who's who" type among two groups of boys, ages 16-20. Boys of mesomorphic (athletic) build were described as "good at games," "real boy," "takes chances," and "leadership." Ectomorphic boys were "bashful," "untidy," "not quarrelsome," "admissive."

Personality was found to be a factor in selecting physical activities by Flanagan (33). Results indicated that fencers seemed to be more dominant, more feminine, and more extroverted than those engaged in badminton, basketball, volleyball, boxing, and swimming. Volleyball players seemed to be more submissive, more introverted, and less emotionally stable.

Nelson (71) studied the personality and attitude differences of those who chose ROTC in preference to the physical education program. The military students were less in favor of physical activity and competition, and displayed a withdrawing disposition in social situations. They preferred organized, uniformed groups and had a more favorable attitude toward authority and position.

Cabot (19), in studying the relationships between characteristics of personality and physique in adolescents, found that a good physique disposes boys to develop traits of self-expression, social acceptability, and physical vitality.

An analysis of data covering ten years at the United States Military Academy by Appleton (2), revealed significant positive relationships between physical ability of cadets at the time of entrance and the criterion of success or failure to graduate from the Military Academy.

Ragsdale (76) compared 45 women physical education majors and 45 nonmajors in the ratings given by high school principals. The two groups were equal in appearance, manners, and purposeful use of time. The physical education group was superior in leadership and initiative, and more of this group displayed a high degree of emotional control.

Bayer and Reichard (5) reported that somatic androgyny indicates a relationship between physique and certain psychological reaction patterns.

Social Mobility

The social mechanism called social mobility involves many factors which become social sifting devices for selecting, promoting, or demoting individuals and distributing them in terms of social class. Athletic sports and games, as common denominators, bring youth from various socioeconomic levels together on a common basis. The athlete in school tends to become more

socially mobile than the nonathlete and, other things being equal, has greater opportunity to achieve upward social mobility.

Annarino (1) found a critical ratio of 9.0 favoring greater campus social mobility for Purdue athletes as reflected by their dating girls in socioeconomic levels superior to their own.

La Place (56) studied personality traits in relation to success in professional baseball. Results indicated that major league players were better able than minor league players to apply their strong drive toward a definite objective, to adjust to occupations requiring social contact or the ability to get along with others, and to exercise initiative.

Popp (74) had five administrators and teachers select ten boys "most nearly like sons they would like to have" and ten boys "least like sons they would like to have." Of the boys who fell into the desirable category, 69 percent had high PFI's; of the boys in the undesirable category, 75 percent had low PFI's.

Cowell (25), in a study of 1400 boys and girls in grades 7 to 12, indicated that the purposes students try to satisfy in physical education change with the process of maturation but "mastery of game skills," "to have fun," and to "learn to control myself and be a good sport," are strong in both sexes. Muscular development is strong for boys at all levels but is a fairly strong purpose with girls only at ages 12 and 13. Social purposes related to submerging one's ego for the good of the team, "to be with my friends," and "to get along with and understand others" are well up in the upper half in the ranking of student purposes by both sexes.

Cowell, Daniels, and Kenney (24) studied the purposes that 500 male first-year college students endeavored to fulfill by means of physical education activities. The students considered that purposes such as "to learn to control myself and be a good sport," "to make new friends," "to feel that I belong to a group," and "to get along and understand other people," had the same index of strength as the purpose "to develop strong muscles."

Social Integration

An integrated social group is one in which there is a great deal of social interaction within the group and people are bound together by such organizational bonds as common goals and purposes. A good team and a good school as miniature societies illustrate integrated social groups. The quantity and quality of friendships developed by students in a physical education class or on an athletic squad should be a concern of a good teacher. They are also personal concerns of students. In a well-integrated social group each individual would tend to accept every other individual in the group at a close personal distance.

Trapp (101) revealed in his study the evidence of social integration possible in a college football squad. The process of social integration in the team, as a whole, was positive and continuous throughout the season. There was an increase of social acceptance of the freshman by the seniors. There was a

positive and continuous process of social integration between the members of the freshman class. The only subgroups showing an increase in social distance between them were the fraternity members and the independents within the squad. As the season progressed, a decrease in social distance between the linemen was apparent. The backfield men were drawn closer to the linemen in personal distance as the process of social integration proceeded.

Skubic (87) used 326 freshmen and sophomore women in physical education classes in her study. She reported that by placing emphasis on students becoming acquainted with each other as soon as possible, the volume of social interaction over a period of six weeks almost doubled in all cases, regardless of the type of activity.

Gustad (41), in summarizing the research literature dealing with factors associated with social adjustment and maladjustment, noted that those participating in social activities tended to have fewer significant scores on adjustment inventories and to exhibit less maladjustment. They were generally more extroverted, stable, and dominant than nonparticipants. Participation in extracurricular activities was associated, also, with above average academic achievement. This was complicated by the fact that social leaders tended also to be brighter than the average student. There was no evidence that a reasonable amount of extracurricular activity affected grades.

Erwee (32) found a positive statistical relationship between employee participation in the sports activities of a large industrial plant and the merit ratings of supervisors. The merit ratings were based on aspects of dependability, accuracy, efficiency, safety, and social adjustment.

Cowell (23) found that some of the outstanding social traits which homeroom teachers, physical-education teachers, and special observers ascribed to actives and which differentiated between junior high school boys who participated wholeheartedly in the activities of the physical education program and those who did not were "unembarrassed and at home in a crowd," "talkative and active," "gave considerable leadership to the group," "a good mixer," "seems to like and seek social contacts," and other social behaviors indicative of satisfactory adjustment.

Cavagnaugh (20) concluded that students who were well adjusted as measured by the Neurotic Tendency Scale of the Bernreuter Personality Inventory tended to participate in more recreational sports activities and had more hobbies than their fellow students who indicated neurotic tendencies. These relationships were somewhat closer for men than for women.

Walters (107) presented an analysis of the change in social adjustment of motivated and nonmotivated groups in a seven-week bowling class. The results seem to indicate that though both groups became more socially adjusted as a result of group participation and acquaintance, the motivated group became better adjusted than the nonmotivated. The good bowlers seemed to be better accepted socially.

Aggression and Competition

A cooperative school social situation is one in which the goal will be possible of attainment by individual pupils only if all individuals can also attain the goal. Conversely, a competitive school situation exists when the goal is reached by an individual or a limited number of individuals and the rest of the pupils will be unable to attain it. Uniquely, sports and games involve *both* competition and cooperation based on a system of values or rules of conduct which guide the behavior of players.

May and Doob (68) related cooperation and competition to personality and culture. By the use of experimental problems, they came to certain theories or propositions. American children work more effectively in competitive than in cooperative situations. The individual will compete or cooperate in cooperative situations. The individual will compete or cooperate if he feels he can achieve his level of aspiration. In a cooperative situation, the presence of an outside competing group changes the social form of the behavior and the performance of the cooperators.

Greenburg (39) studied the growth of the competitive impulse in the use of building stones. A well-defined and orderly course seemed to be apparent. Children two to three years old showed no competition. The child discovered himself in relation to the material and was interested in functioning with that material. The age group three to four years showed some competition and a little better idea of excelling: the child discovered the other child and was more interested in the social relationship than in the competitive situation. At four to six years of age, the child showed a desire to excel and thus compete. Competition was greatest with the group six to seven years of age. There was increased critical judgment along with the competitive spirit.

Stendler and his associates (89) studied cooperation and competition of second graders through the painting of a mural. In cooperation, every child was to get a prize if the mural was done well. Under competition, they were told that only the best painter would receive a prize. Painting sessions and subsequent play session were observed. Results showed that positive interactions were below negative interactions under individual reward conditions. Subsequent play of the children did not appear to be affected by the experimental conditions.

Johnson and Hutton (48) tested eight college wrestlers with a personality test under three conditions. The first was before a wrestling season, the second four to five hours before the first intercollegiate match of the season, and the third the morning after the competition. Several group tendencies revealed were decrement of functioning intelligence, increased aggressive feelings, and increased neurotic signs in the before-match condition.

Problems of Future Research

The problem of selecting, evaluating, and interpreting current research in social learning and social development resulting from physical education and related areas has been solved with considerable arbitrariness and there are

many gaps. Many existing sources are omitted due to lack of space and the fact that they lie hidden away in many related disciplines such as child development, social psychology, sociology, cultural anthropology, and similar behavior sciences. We need an interdisciplinary approach—cooperative research.

Too much meaning has been read into test scores and behavior profiles without enough attention being given to finding out what such scores and ratings actually mean. We need more quantitative rather than descriptive research to assist more intelligently in the personality, character, and social development of children and youth and enable us to identify more clearly the important factors contributing to socialization.

A few problem areas and needs are here identified.

1. More definitive diagnosis of play behavior and a deeper understanding of the psychology of play.
2. Quantification of projective psychological tests involving play techniques.
3. A realistic approach to the causal factors of delinquency.
4. Social and psychological diagnosis of our present culture patterns related to games and sports in order to see what happens when children are pushed into excessive competition before they are emotionally and physically ready for it.
5. More research in the relationships of play, physical education, and recreation experiences to the psychosocial development of people.
6. Simplification of sociometric techniques and a wider use of these in physical education.
7. The study and use of play histories in understanding personality development and the etiology of mental illness.

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The Contributions of Physical Activity to Psychological Development

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THE PARENTS, EDUCATORS, recreation leaders, clinicians, and therapists who advocate activity, play, or exercise have in mind some benefit to be derived. The parent may assume it is an inevitable part of the child's growth. The teacher sees it as a means of modifying behavior and improving the individual's capacity to live more fully. Those from the medical profession see some preventive or remedial goal. But everyone consciously or unconsciously sees more than a physiological organism going through motor gyrations or having fun. Each recognizes that play and exercise have some effect on the behavior patterns of the person.

When one deals with the concepts of motor movement and psychological derivatives and concomitants, one is led to an entity which man everywhere recognizes as "play." Huisinga says:

> This intensity of, and absorption in play finds no explanation in biological analysis. Yet in this intensity, this absorption, this power of maddening, lies the very essence, the primordial quality of play. Nature, so our reasoning mind tells us, could just as easily have given her children all those useful functions of discharging superabundant energy, of relaxing after exertion, of training for the demands of life, of compensating for unfulfilled longings, etc. in the form of purely mechanical exercises and reactions. But no, she gave us play, with its tensions, its mirth, and its fun.
>
> Now this last-named element, the fun of playing, resists all analysis, all logical interpretation. As a concept, it cannot be reduced to any other mental category. . . . It is precisely this fun-element that characterizes the essence of play. Here we have to do with an absolutely primary category of life, familiar to everybody at a glance right down to the animal level. We may well call play a "totality" in the modern sense of the word, and it is as a totality that we must try to understand and evaluate it.
>
> Since the reality of play extends beyond the sphere of human life it cannot have its foundations in any rational nexus, because this could limit it to mankind. . . . Play cannot be denied. . . . In culture we find play as a given magnitude existing before culture itself existed, accompanying it and pervading it from the earliest beginnings right up to the phase of civilization we are now living in. We find play present everywhere as a well-defined quality of action which is different from "ordinary" (17:24).

In this interpretation of play, the educator, the sociologist and the anthropologist more or less agree. Mead (44:44), speaking from the anthropologist's view, says that all the elements of a game are quite deeply human and that therefore games can be easily communicated or transmitted. It is the process of the game that is important to the players. According to a saying, sometimes attributed to the Dutch, "It is not the marbles that matter, but the game." And as Huisinga (17:49) points out, "Success gives the player a

satisfaction that lasts a shorter or longer while as the case may be." Some of the fruits of that success are prestige, a sense of superiority, and satisfaction of that fundamental need to be honored and praised for one's excellence.

And so whether the physical educator is philosopher and anthropologist enough to visualize the human compulsion of the activities done freely, without work goals and objectives, he is nevertheless practical psychologist enough to observe the inherent elements which operate to mold the behavior of the individual and of the group. It is on this basis that we have stated our claims for psychological outcomes. And in these claims can be seen the close interrelationship of health, physical education, and recreation.

These claims may be summarized as follows:

1. Changing attitudes
2. Improving social efficiency
3. Improving sensory perception and responses
4. Developing sense of well-being—mental health
5. Promoting relaxation
6. Providing psychosomatic relief
7. Acquiring skill.

For the past three or four decades the literature pertaining to play, to physical education, and to recreation have made assertions within the framework of the above points. Cowell, Daniels, and Kenney (11) give a report which more or less summarizes views. They include many of the above points in their study of values. The entire AAHPER yearbook, *Developing Democratic Human Relations* (3), is based on the premise that health, physical education, and recreation contribute to personal and interpersonal relations and to the individual's attitudes.

These assertions are perhaps more profoundly believed today than ever before. Let us examine the evidence accumulated through the work and publications of those doing research.

Attitudes Are Changed

Attitude is a feeling or mood relative to action. The professional concern is for attitudes which are relative to learning of motor skills, participation in physical education classes and in recreational use of the skills acquired, to physical activity as a way of recreation, to use of prescribed exercise for maintenance of fitness, or for therapeutic purposes, to development of appreciation of excellence in movement, and many others.

It is recognized that attitudes are frequently in flux. If they are not improving, they are apt to deteriorate before long. The factors considered to have a bearing on these attitudes include such diverse matters as appropriateness of the activity for the ability and maturation of the class, the method of instruction and class conduct, and the freedom of the individual to choose and determine his own activity and goals. It appears that this is an area in which comparatively little has been done to verify our observations and assumptions.

The tools for measuring attitudes are fairly numerous. Wear (63) constructed an effective attitude scale for the college man with respect to physical education classes, and Plummer (41) developed another for the college woman. McGee (31), Scott (50), and McCue (30) developed scales for attitudes of parents and teachers toward athletic competition. Bowman (8) constructed scales both for the elementary school child and for measuring parent attitude toward the child's active play experiences. All these show individual differences ranging from "highly favorable toward" to "indifference" and "highly antagonistic."

Attitudes toward health have also had some study. Kent and Prentice (24) stated increased interest from use of motion pictures in classes. Turner and others (58) studied health attitudes, knowledge, and practice with apparent high interest in obtaining facts on health topics.

In the area of recreation, attitudes have been studied primarily through inquiries about the individual's interests or desires, or "what he would like to do" or "knows he should do." However, the reports on what he actually does show a wide discrepancy. Examples of this may be found in Adams (1), Toogood (60), and Wylie (65). These leave the reader with the question as to whether attitudes are as effective in governing action as we are prone to think and also with the unanswered question of the effect of rapid change in attitudes.

There has been very little done in the study of modification of attitudes. If Smith's (57) "level of aspiration" can be considered as an expression of attitude, then we have evidence on effect of success and failure in an athletic situation. The level rose with success and dropped with failure. The failure group also tended by overt action to escape from the failure producing situation. This seems to be in accord with the observations of teachers, coaches, and recreation leaders and may largely account for the drop-outs in recreation programs.

Annett (2) hypothesized that skill determined level of interest and attitude toward participation. He found in the area of dance that the earlier the age at which dancing was started and the more frequent the experience the greater the skill and the interest. The most popular dance was the one best known.

Plummer (41) found several factors affecting attitudes of the college woman toward physical education. They were mostly personal problems such as competition of other interests, physical appearance, previous experience, finance, and response to the group, but also the facilities and general environment.

McAfee (28) reported on a test of sportsmanship attitudes for sixth, seventh, and eighth grade boys. Progressive deterioration of attitude seemed to call for some revision of teaching methods to alter this trend. This again emphasizes the assumption that attitudes can be modified and that changes can be a direct objective of teaching.

The evidence is far from adequate on questions such as relative importance of different factors in affecting attitudes; individual differences in response

to these factors and in "fluidity" of attitudes; relationship of attitudes to actual overt response in the presence of group stimulation, and other motivating stimuli.

As to the value of attitudes, little doubt remains from educational research or experience that intent to learn, receptivity, and motivation toward learning and participation are conducive to accomplishment and lack thereof is inhibiting.

Social Efficiency Is Improved

This suggests a broad area of human functioning. Professional goals deal with the individual's capacity to be a part of a group and to accept and work with other individuals in the group. Likewise, the individual is expected to demonstrate characteristics of integrity and honesty, fair play, acceptance and understanding, generosity, reliability, and other characteristics considered to be indications of a mature and socially desirable personality. Allegations with respect to character and personality growth are broad, covering development through participation in learning situations, engaging in competition, and establishing patterns of recreation participation. This development is alleged to make the individual more mature and more socially acceptable in a moral and ethical sense. At the same time that he emerges as a strong personality he also becomes an asset in the social groups of which he is a part.

Research, of course, deals with fragments of this problem. Our answers to the total must be built on a summation of evidence.

Probably the greatest amount of research to date has been in the area of social interaction and the development of the sociometric tools and methods of analyzing them. These are products also of the last 15 to 20 years. Breck and Skubic were among the first to adapt the work of Mareno (32), Jennings (21), and others to physical education groups. Breck (9) developed scoring methods. Skubic (50) used the test on classes which were taught as usual with the additional objective of trying to promote acquaintanceship within the class. Fewer social isolates were found and more social leaders emerged during a six-week period. They agreed with Jennings that leadership and isolation are products of interpersonal interaction rather than attributes of persons. Perhaps one of the important findings here is that change did occur, a fact substantiated by Yukie (66).

Fulton and Prange (13) used this technique for comparing motor learning of the chosen and unchosen class members. They found no significant difference for the college women. On the other hand, McCraw and Tolbert (29) found a relationship between sociometric status and athletic ability of boys.

This problem is discussed in more detail in the article by Cowell in this supplement. However, it is essential to relate interpersonal patterns to individual behavior responses, and so it is presented briefly here.

Almost as much interest has been shown in personality changes in the individual. Because of the nature of the personality scales, these are apt to be interpreted as indicating good or poor social adjustment. Biddulph (6) found

such a high relationship between athletic achievement and social adjustment that he emphasized the importance of athletic experience for all. Bentson and Summerskill's (5) study of the entering college man seems to indicate a relationship between social adjustment and success in athletics. This is a point often ignored in studies or observations of outcomes and may have led to erroneous conclusions. However, Biddulph was studying the younger boy and at that age adjustment may be more readily occurring. When considering the participant versus the nonparticipant in Little League baseball play, Seymour (51) found no significant difference in terms of needs and problems or in personality traits except "leadership." Here the participant started higher and gained more. Seymour by hypothesis, measurement design, and conclusions does recognize that with regard to personality the participant starts at a higher level and maintains it. It is failure to recognize this higher starting point that has led some authors to attribute more marked gains from competitive athletic programs than are actually demonstrated in their measurements.

Closely associated with this matter of adjustment is the effect of method. Todd (58) experimented with the "democratic" method and through sociometric analysis found improved acquaintanceship, upward mobility of most students, fewer isolates, better group cohesion, and group approval and satisfaction. Similarly Walters (62) found that group cohesion and unity improved as well as motor performance under motivation of team organization and recognition. The same was found for dance experiences. Page (38) said that when groups are working together, rhythmic cooperation has the ability to synchronize the efforts of the many who are concerned with the common task and to increase the pleasure and efficiency of the participants.

The other aspect of this problem which has been studied is the immediate and temporary effect of competition in athletics upon tensions and emotional control. Johnson and Hutton (22) believed they had demonstrated that the projective test is suitable to identify the altered pattern of precompetition anxiety, body consciousness, and aggression, and the postcompetition release whether or not subjects won their wrestling event. Husman (18) also used projective tests and differentiated athletes in boxing and in other sports and the changing characteristics before and after competitive seasons.

Ulrich (61) also found "prestress" effects which were greater for the inexperienced than the experienced group where sport competition was the stress variable. In the poststress period the experienced group showed greater effects if they had not been permitted to play and the inexperienced group showed highest stress evidence if they had participated. Ulrich used evidence of eosinophil in the blood. Skubic (52, 54) worked in a similar problem with boys in Little League by means of the galvanic skin response. Both agreed that competition in Little League play had no greater effect than competition in physical education classes.

All of this evidence seems a bit inconclusive as to meaningful changes. Seymour makes a conclusion which probably summarizes the situation in terms of present evidence.

As a final conclusion of this comparison of behavior characteristics of participant and nonparticipant boys in Little League Baseball, it would seem prudent to exercise caution in ascribing with any degree of certainty behavioral changes, whether desirable or undesirable, to Little League Baseball or to any comparable program for youth (51:346).

It is by uncritical quotation of certain findings that the total issue is obscured. Such an example is found in that of Hale (14). He falls into the error sometimes made in statistical interpretation of talking about significant findings in the absence of statistical significance. On such erroneous interpretation he then goes on to say that competitive athletics are not detrimental but rather beneficial for pre-high school age children. He further quotes Skubic (53, 54) as confirming his case. But at another point he says that more studies need to be made before the final report can be prepared. Longitudinal studies are needed, as well as more study of emotional responses, on the effect of rejection from participation and on effect of athletic competition for girls.

Skubic's statement on the present status of information is very clear.

It should be remembered that this study was concerned with only one phase of the total problem of competition—the immediate effects of competition on emotionality. In order to completely solve the problem of highly organized competition, data must be gathered relative to the physical, sociological, psychological, and economic aspect of competition. Furthermore, to resolve the specific controversy concerning emotional effects of competition, it is necessary that additional data be secured particularly in regard to the influence of emotion on personality now and later in life (52:351).

Since psychiatrists attribute most of the psychological problems of youth and adults to earlier experiences and their emotional impact on later behavior, it would seem that actual "value interpretations" must wait for more objective evidence on long-term behavior patterns and personality characteristics.

Improved Sensory Perception and Responses

Claims in this area are less frequent, at least in written form. Yet it is from isolated instances and studies based on such hypotheses that recognition seems desirable in this review. These cases range through reaction time, depth perception, visual perception, speed, kinesthetic awareness, and empathy.

Olsen (37) attempted to determine if relationships exist between degree of athletic success and reaction time, depth perception, and visual span of apprehension—and whether differences exist between athletes in various sports. In general, relationships were found, but sports differences were not. In a still broader series of psychomotor tests fencers and nonfencers were nondifferentiated (40). Keller (23) studied athletic groups on "quickness of movement" and Slater-Hammel (55) studied balance in athletic groups of varying skill levels. Both found their groups differed but like Olsen refrained from attributing these increments to increased experience. In light of present knowledge, the hypothesis that possession of the trait contributes to athletic success is as plausible as the reverse, that is, that athletic experience produces a higher degree of the capacity.

The effect of activity on kinesthetic awareness is a debatable point, partly because of lack of evidence, but also because of lack of agreement on a precise definition of kinesthesis. Research to date does indicate a high degree of specificity in kinesthetic functioning (46, 48, 64). This is partly responsible for the lack of clarity in definition.

Those who propose the concept of an improved kinesthetic awareness from physical activity are doing so on the premise that learning takes place here in the same way that musical training may improve the individual's perception of quality or tone differences, or that experience can help the discriminative capacity of the person in the sensations of taste or smell. The other basic hypothesis is that higher kinesthetic acuity is associated with greater achievement. At least a few studies have been conducted on these hypotheses. Typical of these are Roloff (45), Honzik (15), Lafuze (25), Mumby (36), and Phillips (39).

Evidence in general does not support such hypotheses. However, the imperfections of measures on both learning and kinesthesis may be responsible for the apparent lack of evidence. It appears to this author that it is too early to draw conclusions.

Empathy is another of the human responses to what one sees going on. Physical educators have considered empathic capacity as the very basis of appreciation of quality in performance, of esthetics in movement in general or dance in particular; of ability to see detail in demonstrations or observations as one goes through the learning process. The difficulty here is similar to that in kinesthesis. The educator and the researcher are talking about an entity within another human being, an entity which has no check in the same way one can verify that the subject sees the same color as the investigator, or hears the same whistle another hears.

As to the values of these sensory capacities, we can conjecture that they may facilitate learning, provide capacity for better neuromuscular performance, and enrich living in general by making the person more sensitive and responsive to his environment. However, our research to date does not give us a basis for confidence in the outcomes or for building a premise of values.

Improved Sense of Well-Being

Good mental health is sometimes defined as being comfortable with one's self and with others. This has very broad implications if considered carefully. The health and physical education teacher and recreation worker claim mental health outcomes from physical activities and affirm the claims of their colleagues in the related health fields. The physical activities considered are particularly those labeled play, that is, having a fun or diversionary function, and those serving to redirect effort or to afford emotional release or creative outlets. The educator and recreation worker are most prone to base such assertions on case studies, that is, an individual carefully observed in his work, or on the clinical records and conclusions of the psychiatrists and physicians.

Jackson and Todd write comprehensively of the outcomes and values of play, based on extensive research on and therapeutic treatment of the very young child. Their interpretation of play and its meaning is revealed in the following quotation:

> It [play] has educative as well as enjoyment value, yet in a broader sense than either Gross or McDougall assigned to it. The child's learning through play is more subtle and more general than is implied in Gross's theory, and his acquisitions far less obvious. By playing the part of father, mother, engine-driver, or doctor, he acquires no knowledge of how to behave in these parts when he grows up. What he does achieve is the experience of imaginative identification and intuitive understanding; what he gains is not practical skills, but an inner balance on which depends his future emotional development and the success of his relationships with other human beings (19: 12).

The goals of the physical educator and recreation leader are based on evidence and conclusions such as that cited in the quotation and source above. It is commonly conceded that these goals are logical for the school-age child and perhaps even for the younger ones of the teen-age level. There are many outside the professions of play leadership who doubt that there is any necessity or value other than a fun value for the adult in his play activities. Again the best evidence on mental health values comes from the psychiatrist. William Menninger writes from experience in the clinic and on research associated with patients in the clinic. The following quotations represent his conclusions from this evidence.

> Mentally healthy people participate in some form of volitional activity to supplement their required daily work. This is not merely because they wish something to do in their leisure time, for many persons with little leisure make time for play. Their satisfaction from these activities meets deep seated psychological demands, quite beyond the superficial rationalization of enjoyment.
>
> Too many people do not know how to play. Others limit their recreation to being merely passive observers of the activity of others. There is considerable scientific evidence that the healthy personality is one who not only plays, but who takes his play seriously. Furthermore there is also evidence that the inability and unwillingness to play reveals an insecure or disordered aspect of personality (33:343).
>
> Good mental health is directly related to the capacity and willingness of an individual to play. Regardless of his objections, resistances, or past practice, any individual will make a wise investment for himself if he does plan time for his play and take it seriously (33:345).
>
> I also wish to point out the fact that the most constructive and beneficial play is something that has to be learned and is not likely to be an accidental ability or an inherited trait. For maximum satisfaction, one requires not only encouragement but almost always some instruction.
>
> An effective community recreation program is just as important to mental health as sanitation is to physical health (33: 346).

Surely these statements make it clear that every individual has need for participation in some type of play activity and that instruction in these play skills is very important.

The Josiah Macy, Jr., Foundation-sponsored Conference on Group Processes made an analytical study of games and their effect upon children's be-

havior. Chairman of the conference was Fritz Redl, of the Child Research Branch of the National Institute of Mental Health (44). He attempted to guide the conference through a "mental hygiene assessment" of game ingredients. The record of the conference discussion represents a philosophical weighing of game structures by a most competent interdisciplinary group of scientists; it should be read by all who deal with games as a means of helping the individual and should be a basis of very careful selection of play activity. This is indicative of one kind of research which we could promote within our own profession and in collaboration with the psychiatrist and psychologist.

Better Relaxation Is Promoted

Relaxation is here referred to as the capacity to release muscular tension from whatever cause derived and the capacity to adjust effort in amount and sequence for a smooth, efficient functioning of *all* aspects of motor response.

Hypertension and relaxation have been among the harder aspects of human behavior to study. One of the earliest comprehensive statements is that of Rathbone (42), who also has a more recent volume (43). These verify the possibility of modifying degrees of hypertensions and are in agreement with medical clinicians, such as Jacobsen (20) and Zeiter and Lufkin (67). All agree that education has a responsibility in this aspect of health learnings.

Probably the greatest contribution of Bullen (10) is to emphasize the individual variations in response to stress and tension producing environments.

The effect of exercise directly on relaxation is open to some doubt, probably because it varies with types of exercise and conditions under which the exercising is done. Mitchem and Tuttle (35) found magnitude of hand tremor (indicating stress) to vary directly with intensity of arm exercise, leg exercise, and general fatigue from work on the ergometer. Slater-Hammel (55) failed to find the same results with respect to leg exercises. Scott and Matthews (49) also failed to find this relationship in strenuous exercise of various types, and unpublished research by this author failed to find this relationship. It appears probable that other stress factors are more important in exercise well below all-out effort.

It would appear more probable that exercise tends to relieve these other forms of stress. This would support a popular assertion of the health and physical educator. This seems to be supported by Michael (34), who theorizes on the basis of his findings that regular daily exercise improves the organism's ability to withstand emotional stress through hormonal effects on the nervous system.

The value of a tension-releasing medium could not be denied in the present state of society and world affairs. However, the objective evidence is far from complete. This is an area in which those in health, physical education, and recreation could join efforts with the physiologist and psychologist.

It also appears likely that variations in the activity and its outcome affect the degree of tension or relief therefrom. That is certainly indicated in Bullen's (10) investigation of work by adults. Likewise, Baldwin and Lewin

(4), working with children in "success and failure" situations found emotional states resulting from exposure of ability. They also interpreted their results and others as indicating that test failure tends to produce increase in speed and decrease of accuracy in repetitive motor tasks.

Relief Provided on Psychosomatic Problems

It has been medically demonstrated that certain physical states are at times at least partially of psychogenic origin. These states vary from hysterical paralysis to chronic fatigue, psychological limits of work output, discomfort from bodily function, and the like. We are therefore dealing with a condition not unrelated to the one discussed above, hypertension versus relaxation.

The health, physical education, and recreation claims in this area are concerned more with chronic fatigue, fatigue postures, dysmenorrhea, phobias, and the like than with the clinical cases more often seen by the physician and psychiatrist. While the statements are common that exercise and recreation are diverting, are a means of releasing tension, and are a means of improving one's sense of well-being, there is little on specific conditions.

Posture therapy and prevention are substantiated more on the basis of physiological and mechanical improvements. Nothing is presented in evidence on the psychological ramifications of postural deviations.

There is probably more objective evidence on effects of exercise on dysmenorrhea than on any of the other aspects. Lundquist (27) found regular exercise over a period of several weeks relieved dysmenorrhea in its various symptoms, except for the women known to have structural defects. Cessation of exercise tended to revive the dysmenorrhea. Hubbell (16) went further in study of exercise effects by introducing a placebo exercise series. This group on nonspecific exercises had as much relief as the other two groups, leading her to hypothesize that there might be a psychic factor in the relief oriented presentation of the series. Billig (7) and Dick and others (12) give too little actual data on which to evaluate conclusions, but the high incidence of favorable modification of work habits would lead one to hypothesize in line with Hubbell.

Skills Are Acquired

The problem of skill learning and how it occurs is presented thoroughly in pages 321-50. It is beyond the scope of this chapter but is mentioned here because it is believed important that we recognize the psychological implications of the learning process and not just the recognition of learning or its absence.

Physical education has suffered from the old adage "practice makes perfect." It has led to wasted time under the supposed tutelage of the educator and to frustration in those practicing both with and without the educator's supervision. We would do well to remember the importance of our instruction as cited by Menninger: "For maximum satisfaction one requires not only encouragement but almost always some instruction." This was a statement

made to recreation leaders and should point to opportunities for instruction in recreation programs, not just a permissive program of participation and play. It would seem to be imperative to learn more about *how* learning takes place and all the conditions which affect learning.

Summary

There is perhaps no area of our professional background that offers more challenge to us than psychological development. The challenge is multiple. We need a better background in general psychology, personality development, social psychology, and cultural anthropology. We need to develop research competencies in these areas and to pursue our understandings of prophylactic and therapeutic contributions of experiences in motor skills. As teachers and administrators, we must be ready to modify our practice in line with new evidence.

The 1954 yearbook of the American Association for Health, Physical Education, and Recreation, *Children in Focus*, has a concluding chapter by Dorothy La Salle, entitled "Looking Ahead." Her words would seem to set the challenge for consideration not only of psychological development but of all areas represented in this 75th anniversary supplement.

> To look ahead with any degree of hope implies that we know where we want to go and where we now are. The profession of physical education is in substantial agreement regarding where it wants physical education to go. . . . Where are we now in relation to these goals? Are we realizing them for the boys and girls of the nation? Indications in many instances are that we are not. . . . The problems in school health today are essentially the same as they were a generation ago. . . . Do these things happen because we do not yet believe that education for leisure is important? Do they happen because the school is not yet assuming responsibility for improving cooperation between agencies which promote recreation?
>
> What then is the task? The job is difficult and has many facets: to study, to conduct research, to glean the facts from other disciplines which bear on health education, on physical education, and on recreation; to improve the education of teachers, to work unceasingly for improved facilities, instructional aids, and time allotment; to integrate our work in schools with community resources; to become expert in sound argumentation. These are the tasks for the next decade (26:276).

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The Contributions of Physical Activity to Skill Learning

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SKILL DEVELOPMENT HAS long been recognized as one of the most important objectives of physical education, and it is often accepted as a desirable objective of some recreational situations. Some authors have gone so far as to say that the accomplishment of goals in physical education is dependent on the amount of emphasis placed on skill development. Among these are Solley and Damron (185), who indicated that current programs in physical education reflect three philosophical levels in the learning of skills, namely, recreational, pedagogical, and pattern of life. The pattern of life level involves emphasis on the development of habits of performance and sufficient insight into the use of skills in game situations. These authors stated that practice of skills to the point of habit formation increases the probability of the subsequent use of these skills. The development of the individual to optimal accomplishment in the physical, social, and mental aspects of life, through the development of skills in physical activity, is the logical direction for the physical education and recreation program to follow.

The current emphasis on fitness has resulted in many writings concerning the roles of exercise and physical education in physical fitness. Steinhaus and others (190) have stressed the importance of developing and maintaining high levels of agility, motor coordination, power, and speed of movement; they asserted that games, sports, swimming, rhythmical activities, and prescribed exercises play distinctive roles. During the Second World War, Hellebrandt (84) made a plea for a return to greater emphasis on the biological objectives of physical education through vigorous exercise and skill development.

At a recent meeting of the College Physical Education Association, Hubbard (98) defined learning as an increase in effective, adaptive behavior or an increase in performance, while Henry (87) defined motor coordination as an act in which all muscles involved in a movement work together cooperatively and in normal sequence to achieve an accurate and efficient movement. Henry indicated that coordination and skill have much in common, but both large muscle and small muscle coordinations are highly specific. He defined motor learning as the improvement in skill.

Definition of Skill Learning. For the purposes of this review of research, skill learning is defined as progress toward better performance in motor activity as a result of instruction and/or practice. Motor activity includes all specific and generalized movements involving motor coordination, and better performance implies progress resulting in improved motor coordination. Increased strength or endurance and changes in flexibility are considered beyond the scope of this review.

Statement of the Problem. The purpose of this study was to locate the values or contributions of physical activity to skill learning supported by published research, for the most part in periodicals published in the United States. Although a few studies were found that were completed in the 1920's and one as far back as 1915, the bulk of the reports were published between 1930 and the end of 1959. More than 200 studies were found in the psychological journals, dealing with the learning of fine motor skills, such as pursuit meter tracking, maze learning, tapping, and mirror drawing. Due to lack of space, these studies are just summarized in this report and are not included in the bibliography.

Relationship Between Ability and Motor Skill Learning

It has been assumed by many that individuals with higher levels of motor ability can learn motor skills more easily and quickly. Very few studies were found in the psychological literature to support this hypothesis. One study established a relationship between motor ability and typing ability and two found high intercorrelations between different motor skills.

In the area of relationships between motor ability and athletics, dance, and specific sports, the findings were scattered and varied. Kammeyer (103) measured the motor ability of high school girls and found a high, significant relationship with athletic participation. In comparing nonathletes and lettermen in college, Girolamo (72) discovered that the athletes could jump higher, perform more squat thrusts, and had higher Iowa Brace scores of motor ability. Dorcus (50) reported athletic men and women superior to nonathletes in measures of steadiness, tapping, strength, and motor coordinations, and where improvement was studied, the athletes showed greater learning.

Reaction time and speed of movement in skilled and nonskilled sports performers were investigated by a group of researchers. The skilled athletes were found to be superior in studies by Burpee and Stroll (24); Pierson (163), with fencers; Younger (216), using women tennis players, swimmers, fencers, and field hockey players; Westerlund and Tuttle (204), with track men; Slater-Hammel (181), using college varsity athletes; Sigerseth and York (177), with high school basketball players; Burley (22), using college letter winners; and Beise and Peasley (6), with archers, golfers, and tennis players. Kroll (115), however, found no significant difference between successful and unsuccessful performers in their response time for wrestling maneuvers.

Keller (106) administered a series of tests involving quickness of body movement to 259 athletes and 277 nonathletes. The athletes scored significantly better than the nonathletes on all phases of the tests. The above research supports the hypothesis that skilled performers have faster reaction and movement time, but it is not known if this is a result of skill learning or a necessary prerequisite to motor skill development. It might be of interest to note here that Elbel (58) found varied effects of strenuous exercise on the response time of men; there was no significant change in finger, hand, and body response time as a result of stool stepping and push-ups, but hand and body response times were shortened by athletic competition.

In a study of eye-hand coordination, Korins (114) reported that basketball and fencing athletes were superior to runners, high jumpers, and swimmers, and these in turn were superior to nonathletes. Spaeth and Dunham (188) and Humphreys and others (100) obtained a high relationship between steadiness measures and rifle marksmanship. Rifle team members were superior to other students in steadiness as reported by Seashore and Adams (174) and Belton and others (7).

Shaffer (175) used team athletes, individual athletes, and nonathletes for measures of steadiness, tapping, strength, endurance, and alertness. The athletes were superior to nonathletes, and the team sport athletes were superior to those in individual sports. Thus there is some support for the assumption that athletes have better eye-hand coordination and steadiness than nonathletes, but as in reaction time, no cause and effect relationship has been established. Eaton (53) showed that exercise in basketball decreased the steadiness of men; exercise in the water for a short period decreased the steadiness of women, but a long period in the water brought the steadiness back to the normal state.

Burley and Anderson (23) compared 51 lettermen and 962 nonathletes in jump and reach measures. The difference was significant, especially so for track, swimming, basketball, and baseball athletes. Their conclusion was that perhaps participation in athletics improved jumping skill; however, there was no controlled experimental evidence to support this.

A few studies have investigated the relationship between kinesthetic perception and motor learning with the hypothesis that a high level of the former would facilitate skill learning. A relationship between motor learning and positional measures of kinesthesis was noted by Phillips and Summers (162) in a study of 115 women in bowling classes. There was some evidence to indicate that kinesthesis was related to learning more in the early stages than later on. Roloff (170) obtained a positive relationship between motor ability and measures of kinesthesis using control and experimental groups learning tennis, bowling, and volleyball. Working on improvement of kinesthetic awareness, however, did not seem to affect the improvement in sport skill.

When students in college archery classes were studied by Hart (81), there was no indication of significant relationship between archery scores and performance in motor ability tests, kinesthesis, and static or dynamic steadi-

ness. Phillips (159) found little or no relationship between phases of kinesthesis and the learning of two motor skills similar to putting and driving in golf. Mumby (146) studied the kinesthetic acuity and balance of 21 wrestlers and discovered that the ability of a person to maintain constant muscular pressure under a changing dynamic condition was significantly related to wrestling ability. It would appear that nothing conclusive has been learned, as yet, regarding kinesthesis and motor learning.

Many have assumed that motor ability or aspects thereof are related to the learning of specific skills. Steinhaus (189) reported on several studies which indicated characteristics of trained runners and concluded that perfection of movement is the most permanent result of training and the most specific. Anderson and McCloy (2) measured 155 high school girls with a series of motor ability tests; they were also rated as to their ability in various sports. The authors found high correlations between the tests and the ratings. The items most related to sports ability were power and agility. Using an entire university freshman class Hoskins (95) administered a number of motor ability measures, and the students then participated in various activities. High correlations were obtained between swimming and jumping, swimming and general motor ability scores, swimming and track tests, track and general motor ability, and track activity and track tests. In studying the rate of learning motor skills with 275 high school girls, Brace (15) found substantial correlations between the learning of rhythms, hockey, tennis, stunts, and volleyball and tests of motor ability.

Scott (173) obtained some indication that motor ability was one factor determining the learning rate in swimming. With 78 male advanced swimmers, Gross and Thompson (79) found a relationship between dynamic balance and swimming speed, while Slater-Hammel (182) discovered that 22 varsity athletes had better balance than 22 physical education majors, who were better than 22 liberal arts majors. Walters (201) saw a relationship between motor ability and the learning of bowling. With a group of 42 physical education majors, Benton (9) found that balance, motor educability, agility, and strength were related to the learning of dance movement techniques. Ehrlich (57), with 87 college men, obtained no evidence of relationship of strength, motor ability, educability, or capacity to the learning of a fencing lunge.

Beall (5) gave 163 college women a muscular coordination test of stabbing a foil at a target and then taught all subjects the skills of tennis; when retested in motor coordination, 45 percent improved, 35 percent had a lower score, and 20 percent remained the same. Gross and others (78) found no correlation between two motor educability tests, a strength test, and wrestling ability after eight weeks of instruction. It would appear that there is some evidence to indicate a relationship between motor ability and the learning of skills, but much more research is needed in this area for any general conclusions.

It has been asserted by some authors that strength and power are related to motor skill development. Espenschade (60) measured the children enrolled in seven elementary schools to compare performances on the Kraus-Weber test to those on the California physical performance test involving running, jumping, throwing, and sit-ups. Children who failed one strength item or multiple items on the Kraus-Weber test made lower scores on the average in the California test; the differences were significant in all events for boys but only in throwing for girls. Using 101 children from 6 to 11 years of age, Govatos (75) obtained significant correlations, ranging from .46 to .84, between grip strength and dash, soccer kick, softball throws for distance and accuracy, and standing broad jump.

With 25 men of extensive athletic experience, Rasch (166) found no significant correlations between speed of arm movement and various measures of hand and arm strength. Willgoose (213) tested 300 high school boys in strength and standing broad jump; a definite relationship existed. Similar results were obtained with 75 junior high school boys in strength and the stunt called the crab race, and with 500 junior and senior high school boys in strength and the 50-yard dash. In the testing of 53 college men by Clarke (30), none of the cable-tension strength tests were significantly related to the vertical jump or squat thrusts for 12 seconds; two other correlations between strength and squat thrusts and standing broad jumps were very low.

A number of researchers investigated relationships between strength and/or power and general athletic ability. During a five-month training period, Rarick (164) measured a group of 51 college men, consisting of physical education majors and varsity athletes, mostly track men. Low correlations were obtained between strength and jumping and between various kinds of strength and speed of performance. Shaffer (175) tested team athletes, individual sport athletes, and nonathletes on steadiness, tapping, strength, endurance, and alertness. The athletes were superior to the nonathletes, and team sport athletes were superior to those engaging in individual athletics.

Anderson (3) measured 300 senior high school girls and concluded that strength was not the sole factor in athletic ability of girls and could not be used as a predictor. On the other hand, Carpenter (27) tested 100 girls and concluded that power and strength, in that order, were the two most important factors influencing athletic perfromance; she also found that the Iowa Brace test, when combined with the vertical jump, could be quite accurate in predicting success in athletics.

A study by DiGiovanna (48) involved 836 college men, including 102 athletes; the athletes were significantly superior to the nonathletes in measures of explosive power. In summarizing the results of eight research studies, McCloy (133) concluded that strength correlated highly with general motor ability but was not good as a predictor of sports achievement.

Hart (81) discovered a low but significant relationship between the ability of college students in archery and their strength. Consistently high correlations between measures of strength and baseball tests were shown by Hooks

(94). Ehrlich (57) obtained insignificant relationships between strength and rate of learning a fencing lunge. Strength, as reported by Coleman (34), was a distinct factor which could be isolated in various jumping, running, and throwing track events. Lamp (122) concluded from high positive correlations that strength was important for volleyball playing ability. Significant differences in strength between successful and unsuccessful wrestlers were shown by Kroll (115), while Gross and others (78) saw no relationship between strength and wrestling ability after eight weeks of instruction. From the above it can be seen that the evidence concerning the relationship between strength and/or power and motor skill or athletic ability is conflicting; no conclusions can be drawn at present.

Transfer of training in motor skills has been investigated by far more psychologists than physical educators. In the psychological field there were 14 studies involving transfer from one hand (or foot) to another and 18 involving transfer from one task to another; all but one found evidence of transfer of training. Lindeburg (126) tested 47 high school boys and girls and found no transfer of training from the activities of table tennis, regular physical education activities, or special arm exercises to coordination efficiency in three tests measuring speed of movement.

Nelson (150) undertook an extensive study of transfer of learning in gross motor skills, using 90 men as subjects. With a rotation experimental design, the findings showed that the initial learning of tennis seemed to have some favorable effect on learning badminton skills. When the badminton and tennis skills were learned alternately there was more improvement than when learned separately. The initial learning of basketball skills seemed to aid in the final learning of volleyball skills, and the initial learning of track starts had a favorable effect on learning the football start.

In most of the analyses it was found that deliberate teaching for transfer of learning was ineffective. With the above contradictory evidence no conclusions can be drawn.

Distributed and Massed Practice in Skill Learning

In the psychological field, 45 studies were found. Of these, 40 favored distributed practice and a review of many more showed similar results. Three studies favored massed practice and two indicated no significant difference between distributed and massed practice.

Young (215) compared the rate of learning four days per week and two days per week in college archery and badminton classes. In archery four days per week resulted in more rapid learning, while in badminton two days per week provided more effective learning. Niemeyer (152) found that in early learning of swimming, badminton, and volleyball, distributed practice of 30 minutes three times per week was better than massed practice of 60 minutes twice a week.

In a study by Miller (140), four groups of college women had nine practice periods of 50 shots each in learning the fundamentals of billiards. One group

had practice one day a week; a second, three days a week; a third, daily practice; and a fourth had an additive system of lengthening the time intervals between practice days. There were significant differences in the improvement of the additive group over the other three, but no other differences were significant. In another study in learning billiards, Harmon and Miller (80) again found the additive system of practice periods superior to three days per week for three weeks, daily practice, and once per week, although the significant differences did not appear until after the sixth practice period in each group.

Lashley (125) found distributed practice much more effective than fewer long periods in learning archery and rifle shooting. Webster (202) investigated length and intervals of practice periods in learning bowling and reported that shorter and more frequent practice sessions were most effective. In two studies involving men and boys in learning to juggle, Knapp and others (110, 112) discovered that five-minute daily practice sessions resulted in more rapid learning than did 15-minute sessions every second day. Studying the learning rate of beginning swimmers, Scott (173) found no evidence to indicate any better learning from two, three, or four days per week of practice.

Although some of the physical education research findings agree with those in psychological studies, the evidence is far too scanty to uphold the supposition that distributed practice will result in more effective learning than will massed practice.

Effects of Practice on Skill Learning

Only four reports were found pertaining to aspects of motor skill learning in young children. Muzzey (147) studied the learning of a motor response to a rhythmic pattern with 50 white and 50 colored children; both groups learned as a result of practice, but the learning curves were not the same. Wight (210) gave tests of motor coordination involving speed and rhythm to matched groups of crippled children; after two months of rhythmical activities an experimental group showed a gain of 18.4 percent, while a control group gained only 2.3 percent with no training.

After six weeks of practice in two 20-minute periods weekly, Smith (183) found that 100 children showed significant learning of a ball toss for accuracy and a ball bounce swinging the preferred leg over the ball while in a circle; boys were superior to girls in learning the motor skills. Hicks (91) studied the effects of systematic, well-motivated practice on the ability to hit a moving target with a ball, using 60 young children. Improvement did not result from specific practice but from structural maturation and general practice.

The evidence of learning with boys and girls of junior high school age is a little more extensive. Brace (14) used four sport type learning tests, a stunt type performance, and a rhythm test with 100 girls and studied the learning in 90 performances of each test. There were marked individual differences in ability to learn these skills and differences in the learning with

each of the three types of tests. Espenschade (59) studied the development of motor coordination of 610 boys and girls and discovered practice effects in stunt type tests in girls more than in boys. In a report by McCraw (134) 100 girls were measured in the learning of two motor skills, the ball bounce test and a target toss test, after 30 trials. The percent of gain from the initial test to the final test was significant in both skills.

In another study McCraw (135) used 134 boys in learning a rope-skip test and a mirror target toss test, with 21 and 50 trials, respectively; the total learning was significant. Henry and Nelson (86) measured 145 boys in learning three different sensory-motor skills and found evidence of great individual differences in learning. The results of three weeks of practice in running indicated definite improvement in a report by Kronsbein (116).

The majority of studies have been done with college students to support the hypothesis that learning results from practice. Vandell and others (198) used equated groups of high school and college freshman boys in learning dart throwing and basketball free throws. With no practice there was practically no improvement; mental and physical practice seemed almost equally beneficial. Twining (196) also studied mental and physical practice in a ring toss experiment with 36 college men. Subjects with no practice showed no learning; mental and physical practice both resulted in significant learning, but the learning from physical practice was much greater.

With 49 college women, Espenschade (63) learned that improvement in the scores of stunt-type test batteries resulted from regular practice in activities designed to develop body coordination, strength, flexibility, and control, but specific instruction and practice in the test items themselves in addition to regular classwork did not seem to influence the amount of improvement. Lashley (125), in one of the earliest pieces of research on learning motor skills, found evidence of improvement through practice in archery and rifle shooting. With 75 college women, Hyde (101) discovered definite practice effects at each distance in archery; the achievement followed the usual learning curve. Shroeder (172) also obtained evidence of learning archery skills through practice in a study involving more than 300 women.

With 30 college men, Swegan and others (192) concluded that 50 trials resulted in faster preferred-arm extension than did 20 trials. Henry (88) conducted three motor learning experiments in which 60 subjects showed a marked improvement in vertical jumping during seven trials; the speed of performing a complicated arm movement increased greatly in 30 subjects with 16 practice trials; a large amount of learning in the skill of balancing was observed in 46 subjects during five practice trials. Henry (89) also found a practice effect in ten trials in the Sargent jump with 61 men. Johnson (102) obtained evidence of significant learning to walk a tight wire as a result of practice; this learning was still present after one or two years. In a report by Noble (153), subjects who practiced throwing basketball goals indicated greater skill than those who did not practice.

In a controlled experiment by Brady (17), practice on a volleying test improved not only the score made on the test but also the individual's ability to play volleyball. Espenschade (61) used 40 men and 30 women to study the learning involved in hitting a target with sandbags while blindfolded. Scores improved rapidly and the improvement made in 50 trials was highly significant; men were superior to women in this learning. Cozens (38) found evidence of improvement in the use of the body by regular and continued activity, whether specific to the skill measured or not. Men's bowling records for a period of ten years were analyzed by Hodgson and Vaughn (93); there was evidence of learning, with much individual variation in learning curves. Fannin (65) saw decided progress in learning the standing broad jump; one subject had a total increase of 28 inches in 43 days of practice. Thompson and Stull (195) demonstrated significant learning with men in swimming practice for three weeks.

The more than 25 studies mentioned above support the assumption that learning takes place with practice of motor skills. In the psychological literature, 78 studies showed evidence of learning through practice; two of these showed longer retention with longer practice, and two showed greater effects when subjects worked as a team instead of individually.

Another aspect of practice, though not always specific to the movement skill being learned, is that of warm-up exercises. It has been assumed by many teachers and coaches that warm-up exercises have a beneficial effect on performance. Paseltiner (157) tested college men in speed of elbow extension after no exercise, light warm-up exercise, and heavy resistance exercise; the speed of extension was fastest after light exercise. Lotter (129), however, in a controlled experiment, found no beneficial effect of warm-up exercise with 20 men doing a bicycle cranking motor skill. Pacheco (155, 156) studied the effects of warm-up exercises of running in place with 166 high school girls, and deep knee bends with 50 college men, on vertical jumping; in both reports there was a significant improvement in the groups having preliminary exercises, as compared with control groups.

In a rotation experiment by M[illegible]hael and others (139), 77 college men improved in the softball throw for distance as a result of a five-minute related warm-up, as well as with a five-minute unrelated general warm-up, compared with no warm-up. Skubic and Hodgkins (180), however, with 31 women, obtained no significant effect of related or unrelated light warm-up on bicycle ergometer riding, softball throw for distance, or ten trials of basketball free throws. Sills and O'Riley (178) discovered no value in exercise between bouts of spot running, with 18 college men. Using 54 subjects in a controlled experiment, Blank (10) obtained significantly faster dashes after extensive warm-up as compared with light warm-up. With boys running a 50-yard dash, Hipple (92) concluded that a second race had no beneficial effects on a first race, and similarly with a third race.

Karpovich and Hale (104) used track men to study the effects of deep massage, exercises, and digital stroking preliminary to running the 440-yard

event; preliminary exercise did not improve performance. The same result was obtained by Mathews and Snyder (131) with 50 high school boys in a comparison of extensive warm-up with no preliminary exercise. DeVries (47) had 13 subjects swim three time trials of 100 yards each preceded by no warm-up, swimming 500 yards slowly, hot showers, calisthenics, and a ten-minute massage. Swimming 500 yards was the only procedure that had any appreciable effect. Thompson (194) conducted an extensive study to see if warm-ups affected performance in speed and endurance in swimming, accuracy in basketball foul shooting, accuracy in bowling, and speed and accuracy in typing. Formal warm-up (related activity) improved performance in all skills except typing; informal (unrelated) warm-up did not affect performance in any of the motor skills.

It can be seen from the above three paragraphs that evidence concerning the beneficial effects of warm-up exercise is scanty and contradictory. At least from published research evidence, there is little justification for the practice of warming-up in physical education classes and athletic contests.

Effects of Participation in Regular Physical Education Programs

The procedure of requiring students to participate in regular physical education programs is partially based on the assumption that these programs will result in achieving the major objective of skill learning. This section will deal with research evidence to support this assumption, but the conclusions should be considered in conjunction with those found in the next section, namely, the effects of specific instruction.

Only four reports were found dealing with the elementary school program. Rarick and McKee (165) studied the superior and inferior performers in a group of 172 third-grade children; the superior performers had a history of greater participation in play activity prior to this testing than did the inferior children. Barry (4) discovered that 526 boys showed a gain of 50 percent in athletic badge tests from September to June, and those in schools with a physical education program did better than those in schools without such programs. In comparing 33 boys attending physical education classes with 33 not in class, Garland (70) noted the improvement of the former to be significantly greater in a series of athletic achievement tests. Whittle (206) obtained significant differences in motor ability between boys participating in good and poor elementary school programs.

Espenschade (62) reported that high school boys and girls who participated in extracurricular athletic activities had higher test scores in aspects of motor ability than those who did not. Van Dalen (197) gave tests of general motor capacity to 696 junior high school boys and girls and obtained significant relationships between test scores and participation in play activity.

When McCraw and Tolbert (136) tested 438 junior high school boys, they obtained significant differences between interschool athletes and nonathletes in an athletic index involving 50-yard dash, standing broad jump, and softball throw. Carr (28) found that the freshman girls in a high school showed

definite improvement in a battery of athletic tests after participating in physical education for two semesters. Comparing 88 high school boys in a regular high school physical education program with 55 participating in interscholastic athletics, Danielson (42) obtained no significant differences in the 100-yard dash, Illinois Agility Run, and the vertical jump.

With 79 college freshman women divided at random into four classes, Bennett (8) reported that after 16 weeks of classes the relative status of four activities in the development of selected and general motor abilities was swimming, modern dance, basketball, and folk dance. For agility, basketball, swimming, and modern dance were superior to folk dance but did not differ from each other. For speed and power development, there were no differences in the four classes. Espenschade (64) presented the results of tests given to women in a number of Western colleges which were repeated from seven to ten weeks later; improvement was shown, as a result of participation in physical education programs, in measures of agility, power, and ball handling.

Graybeal (76) conducted an experiment over a two-year period with all entering freshman women; one group participated in the required program and an equated group was not permitted to attend classes. Significantly greater gains in motor ability were shown by the experimental group in the first year; they also made greater gains over a two-year period, but this was not significant. As a part of a larger study, with more than 700 women college students, Mohr (145) found significant improvement in agility after a semester of participation in swimming, recreational sports, dance, or team sports; recreational sports, dance, and team sports seemed to provide greater improvement than did swimming. Petroskey (158) tested 284 freshman women who were taking a course in basic physical education in numerous measures of agility, running, and power; the majority of the students showed substantial gains at the end of a semester.

A comparative study by Weekley (203) indicated that 60 men majoring in physical education had better physical skills than 54 engineering students, who in turn were superior to 100 men majoring in arts and science. Blesh and Scholz (11), from testing 10,000 Yale students over a ten-year period, concluded that agility and coordination could be improved in regular physical education classes when emphasis was placed on these factors and exercises were given at regular intervals. In a program consisting of one hour five times a week for five months, Bookwalter (13) saw substantial gains in all men students in measures of motor ability, agility, power, and speed.

In another study with all college men in service classes, Cureton (41) found an over-all improvement in jumping ability after a year of participation in regular classes of physical education; those in a special fitness clinic showed more marked improvement. Howard (96) reported on the achievement of college men in the game of basketball; all groups showed improvement, but the varsity and Olympic try-out groups were superior to those in regular classes. All incoming freshman men were given fitness and motor ability tests before and after classes in eight different types of activity in a study

reported by Landiss (123). All groups showed improvements, and an extensive analysis was made of the relative effects of the various activities.

Three studies showed the results of physical training in the armed forces. Wieman (209) found that 16,000 trainees showed considerable improvement in agility after 16 weeks of activity. Similar results were obtained by Karpovich and Weiss (105) with over 10,000 men trained for 21 weeks. Larson (124) reported on the improvement in agility, power, and coordination in pilot personnel over a period of one year.

These, and the 20 studies involving students from elementary school through college, constitute substantial evidence that skill learning takes place in regular physical education programs.

Effects of Specific Instruction on Skill Learning

As for the regular program, it has been generally supposed that specific instruction in skill will result in learning. Many of the psychological studies reported earlier on the effects of practice also indicated beneficial effects of specific instruction. Four similar reports pertaining to motor skill development of children were found in the literature.

Miller (141) used two experimental and two control groups of first grade boys and girls to see if instructions in the motor skill of throwing would improve their performance over and above the effects produced by maturation and general practice. The experimental groups showed higher mean gains, but these were not significant. In a controlled experiment with 56 children three to seven years of age, Dusenberry (52) found that instruction twice a week for three weeks in throwing for distance resulted in significantly greater gains than no instruction; there was no difference, however, in improvement in the standing broad jump. In a study by Goodenough and Brian (74), 20 children, aged four and a half, practiced throwing rings over a post for 50 days; the scores of the group that was given thorough instruction showed an improvement of 42.5; a group with some instruction, 17.5; those with no instruction, only 11.5. Kulcinski (118) measured the learning of muscular skills of fifth and sixth grade children; those with superior intelligence showed significantly greater learning than normal and subnormal groups.

In three studies with college men, involving improvement in motor skill aspects of physical fitness as a result of specific instruction in these aspects, Wilbur (211), Hughes (99), and Kistler (109) obtained evidence to support the hypothesis stated above. Soule (187) investigated the effect of ten weeks of handball, badminton, and soccer instruction and practice on tennis ability; all three groups showed improvement in tennis scores. Davies (45) gave an archery class of college women instruction for three months; they were significantly superior to another group which practiced without instruction. Rodgers and Heath (169) presented evidence of the learning of fifth and sixth grade children as a result of instruction in baseball skills, and Edgren's studies (54, 55) showed similar results in the learning of basketball skills.

Gire and Espenschade (71) obtained evidence that the effect of instruction on basketball, volleyball, and baseball skills was more conclusive with basketball than the other two. Phillips and Summers (161) studied the bowling learning curves from scores obtained from 22 different colleges and universities; there was substantial evidence of learning as a result of instruction. Fox (68) also provided evidence of learning in bowling, with 20 subjects. The learning of a fencing lunge was studied by Ehrlich (56); 87 college men all made improvements in speed and accuracy as a result of training. Brace (16) reported evidence of the learning of football skills on the part of 65 varsity football candidates.

Kingsley (108) gave 28 ninth-grade boys 50 class periods of instruction in tumbling; the average number of skills learned in this time was over 17. Learning in handball was demonstrated by Cornish (36) after ten weeks of teaching in six men's classes. Sinizalo and Juurtola (179) found evidence of learning in an eight-week ski training experiment set up to compare the physiological effects of two methods. Heath and Rodgers (83) demonstrated that participation in team play or instruction in soccer provided learning of skill, and more extensive practice provided greater learning.

In swimming, Davis (46) showed results of training on decreasing the time for the 200-yard crawl; King and Irwin (107) presented evidence of learning competitive back stroke turns. In another swimming experiment, Nelson (149) discovered that swimming skills were learned after six weeks of instruction, but this did not affect the performance of volleyball tapping or running high hurdles. Although no relationship was found between rhythmic perception and motor learning, Bond (12) showed evidence of learning table tennis skills after 15 half-hour periods of instruction. Scott's (173) study of swimming showed that learning could be as rapid and great in class situations as in private lessons. Fox (67) found that, in four beginning tennis classes, groups that supplemented teaching with backboard practice made greater progress than those who did not.

In the area of track and field three studies were found. Phillips and Allen (160) compared 50 track and field candidates with 50 ASTP students; both showed evidence of the benefits of training in their final performances. A study by Cozens (37) indicated significant learning after one semester for men deficient in track skills. With only eight class periods of 30 minutes each, Matthews (132) obtained significant improvement with 121 boys. Clevett and Laveaga (32) found more than 40 percent average improvement in volleyball skills after three hours of instruction and the playing of eight games in college classes. Using 56 college men in small classes, Gross and others (78) obtained evidence of learning of wrestling skills.

The more than 30 studies cited above uphold the assumption that specific instruction results in learning of skills, as do the more than 20 reports dealing with the regular physical education program. Although this total is substantial, more research is needed to support the hypothesis for each specific activity; there are many activities in the physical education and recreation program for which no published research has appeared.

Effects of Special Methods of Teaching on Skill Learning

Both psychologists and physical educators have been interested in the relative merits of whole, part, part-whole, and progressive-part methods in the learning of skills. In published research in the psychological journals, two studies favored the progressive-part method, four the part method, four the whole method, and one typing study favored the whole method of teaching. It can readily be seen that no conclusions can be drawn from these results.

The evidence to support one or more of the above methods in published research on the teaching of physical skills is scanty and variable as well. Knapp and Dixon (111) compared the whole and part methods in learning to juggle, using paired subjects of physical educaton men majors and minors; the whole method was superior. In comparing the whole, minor-games, and whole-part methods of teaching basketball to ninth-grade boys, Cross (40) concluded that simpler unitary skills were best taught by the whole method; the most complex skills were best learned in the whole-part method, and intermediary skills were best taught by the minor-games method. McGuigan and MacCaslin (137), studying the rifle marksmanship learning of 348 infantry trainees, found the whole method of learning generally superior to the part method for both slow and sustained firing.

With two equated physical education classes, Shay (176) discovered that the progressive-part method of teaching the upstart on the horizontal bar resulted in faster learning than did the whole method. Wickstrom (207) equated two groups of college men and taught basic tumbling and gymnastic stunts by the whole method and the whole direct repetitive method. There was no significant difference between the two methods on the basis of the total scores of all ten stunts tested, but learning was found to require fewer trials with the whole method.

Two equated groups of college men were given ten weeks of instruction in golf; they played 18 holes, then had six weeks of review instruction, and again played 18 holes. Theunissen (193) reported that the part method was superior on the earlier test, but the whole method was superior on the final test; the whole method was also superior for indoor golf instruction. In comparing the whole, progressive-part, and part methods of teaching beginning tennis to college women, O'Donnell (154) demonstrated that in final playing ability, as measured by the Dyer test, the whole method resulted in a significantly higher level of achievement than either of the other methods; the forehand, backhand, and service tests, though favoring the whole method, did not provide significant results. Niemeyer (152) presented evidence concerning part and whole methods with 366 students. Swimming was best learned by the whole method, badminton was equally good by either method, and volleyball was best learned by the part method.

Other research related to special methods of teaching was extremely varied and difficult to classify; almost as many hypotheses could be identified as there were studies reviewed. As a result of testing school children taught by

special teachers of physical education and those taught by classroom teachers, Zimmerman (217) obtained significant differences in most motor skills in favor of the former. Williams and others (214) reported a comparative study of the improvement in measures of motor skills of a group of fourth-grade children taught by means of formal gymnastics and one taught through informal play; both groups gained in skill, and differences, which were not significant, favored the play group. In a similar study by Dowd and Arlitt (51), girls in a camp situation showed greater gain in motor ability tests through supervised play than through classes in formal gymnastics.

Relative emphases on speed and accuracy were investigated by three researchers. In the initial stages of learning a ballistic movement, Fulton (69) discovered that a group emphasizing speed developed accuracy to a greater extent than one working primarily for accuracy; the speed of the two groups was almost the same in the sixteenth training period. Solley (186) studied three groups learning thrusts at a target. The group emphasizing speed developed significantly greater speed but also became as accurate as the group which concentrated on accuracy. However, the third group, which emphasized speed and accuracy equally, became the most accurate. In a similar study, Solley (184) found that speed developed under initial emphasis on speed was readily transferred into speed and accuracy performance, but accuracy gained at low rates of speed was lost almost immediately when speed was increased. The above results are too variable to provide any conclusions.

Three women researchers have hypothesized that special instruction in basic skills will result in greater learning. Broer (18, 19) presented evidence of this with seventh grade girls and college women; Lafuze (121) and Salit (171) obtained similar results with college women. The last three studies dealt with women of low motor ability, and greater learning took place when these students were in homogeneous classes with respect to motor ability. Lockhart and Mott (127), in a controlled experiment, found that whereas students with superior motor ability benefited significantly by being segregated, inferior performers did not show any more improvement by membership in special classes than they did when grouped with those of varied ability. However, there was no evidence of adjustment of method and class experience to the level of the inferior performers.

It has seemed reasonable to some teachers to assume that the teaching of mechanical or kinesiological principles will facilitate the learning of motor skills; the published research, however, provides very little support for this assumption. Colville (35) conducted a controlled experiment with college women and obtained no evidence that understanding and applying principles facilitated initial learning of three motor skills or the subsequent learning of similar or more complicated skills. Daughtrey (43), in a larger study with 497 junior high school boys, found that classes with a kinesiologically planned program showed considerably more improvement in most skills than classes in which the boys selected the activities and practiced on their own initiative. It should be noted, however, that two factors were operating here, namely, instruction and kinesiological principles.

In a controlled experiment with 90 eighth-grade boys, Hendrickson and Schroeder (85) reported that knowledge of the refraction theory facilitated learning to shoot at submerged targets with an air gun. Hertz (90) obtained no significant differences between overt-practice, overt-practice implicit, and kinesiological methods of teaching one-hand foul shooting in basketball. Phillips (159) discovered that efficiency with respect to some phases of kinesthesis was related to learning to putt and drive in golf, but in other phases there was zero or negative relationship.

Audio-visual aids are widely used in teaching, but little research has been done to defend this use in physical education. In an experiment in teaching tumbling, Brown and Messersmith (20) made films of the performance of college men in an experimental group and used these as teaching aids; the gains made by the experimental group were not significantly greater than those of the control class. Lockhart (128) used two classes of college women in bowling; after the third week the experimental group, which had movies as a teaching aid, was superior to the control group. Nelson (148) failed to find significant differences between two groups of beginning golf students when the experimental group had slow-motion loop films added to the teaching procedure.

In teaching the drive in golf, Griffith (77) blindfolded one group of students; compared to those who practiced with eyes open, the former started with shorter drives and ended with longer ones after six weeks of practice and instruction. Anderson (1) used 132 high school girls in a basket shooting study in which one group practiced with marked spots on the backboard to aid in aiming; this group was superior to a control group after 12 half-hour practices. Dillon (49) found that, with 240 college women in intermediate swimming classes, those taught with music as a teaching aid improved more in swimming form and speed than those taught without music. Other studies have been done with similar findings, but these have not been published.

The research available on special methods of teaching bowling is too varied for any conclusions. Goellner (73) compared the effectiveness of teaching headpin, spot, and combination methods of aiming to beginners and learned that, with 78 students, headpin bowling was superior. Using 72 college women, Summers (191) obtained no difference between hook ball and straight ball deliveries in beginners; contrary to Goellner's results, teaching the spot point of aim was superior to headpin bowling. Walters (199, 200) reported two studies on bowling. In the first she experimented with an approach which emphasized seeing all points in relation to a focal point and making use of all perceptual cues available; those taught with this approach did not learn any faster than those taught in the traditional manner. In the second study, students motivated by posted running scores and team competition showed significant learning.

The remaining reports that dealt with special methods of instruction each tested a different theory. Richardson (167) conducted an experiment to measure the improvement in basket shooting as a result of a physical con-

ditioning program over and above the regular basketball practices; no significant differences were seen between control and experimental groups after 12 practices. In two classes of 75 seventh-grade girls, Whilden (205) compared the performance in basketball after democratic and teacher-dominated methods of teaching. The teacher-dominated class showed better command of basic skills, while the other group showed greater knowledge of the rules, performed better as a team, and won more games. Kulcinski (117) compared formal, informal, and combination methods of teaching college men in fundamental skills; most of the results favored the informal method.

In beginning swimming classes for college women, Ford (66) learned that the front and back methods of teaching the whip kick and the wedge kick method were all about equally effective in terms of final achievement. Cozens (39) reported research using eight classes of college freshmen two years in a row showing that track and field events were learned better with practice periods scattered through the semester, rather than concentrated. Significant differences were obtained by Howell (97) when comparing track students who were shown force-time graphs of their sprint starts with those instructed by conventional methods.

Clevett (31) conducted a study to see if honesty could be developed in physical education and if this would result in less improvement in motor skills. The experimental group, which had instruction in fundamental skills and emphasis on honesty, gained twice as much in motor achievement as the control group, three times as much in aquatics, and three to four times as much in general athletic skills. It would appear that the factor of honesty was not isolated. Haverland (82) compared three groups; one had Danish gymnastics and conditioning, a second regular physical education, and a third had training in the Jacobson relaxation methods. In tests of motor skills, reaction time, and steadiness, the relaxation group showed better coordinated and precise movements. An experimental group, reported by Minaert (142), that had six days of dry skiing instruction before working on the open slope did significantly better in the elementary ski skills than did the control group.

Effects of Weight Training Programs on Skill Learning

During the past decade, many teachers and coaches have asserted that weight training will improve athletic performances and skill learning. A substantial number of studies support this hypothesis with respect to power, both in jumping and throwing events. Brown and Riley (21) used two groups of 20 freshman basketball players, one having five weeks of weight training, the other having the regular physical education professional program. The experimental group developed a significantly greater increase in the height of the vertical jump. With 15 girls on a varsity high school basketball team, Knudtson (113) discovered significant increases in jumping ability after weight training for six weeks.

Mitchell (144) obtained improvement in jumping with 55 college men after nine weeks of weight training. In a controlled experiment with 30

varsity basketball players, Ness and Sharos (151) found significant increases in the chalk jump after four weeks of weight training for the experimental group and decreases for the control group. Capen (26) compared freshman and sophomore men in 11 weeks of weight training exercises with men in other physical education classes; the former showed more improvement in vertical and broad jumps. A similar experiment conducted by Chui (29) over a three-month period produced similar results.

Wickstrom (208) reported that for three years his basketball players participated in a preseason weight training program, and jumping ability was always increased. Since he could not tell whether this was due to basketball workouts or weight training, he studied the effect of a postseason weight training program of six weeks with 13 varsity players. He obtained an average increase of 1.5 inches in jumping height over the performance at the end of the basketball season. Only one study was found that did not unhold the supposition that weight training will increase jumping ability. Roberts (168) compared the effects of jumping exercises and weight training exercises with regular practice, using basketball players, and found no significant differences after eight weeks.

The evidence concerning shot put and throwing power is conflicting. Capen (26) and Chui (29) found evidence to support the hypothesis, while Mitchell's results (144) showed no improvement in the shot put from weight training. Minor (143) compared two types of weight training exercises with regular baseball practice and found no differences between groups in the mean velocities of basketball overhead throws.

Speed of movement was studied by several researchers, and most of the evidence indicated that weight training had a favorable effect. Chui (29) reported that times for the 60-yard sprint improved after three months. Meisel (138) compared 100 subjects from four sports classes with 60 men from three weight training classes in speed for a 10-yard run; the control group had sports lectures while the others had weight training. The experimental group showed significant superiority. Masley and others (130) found that greater improvement in speed of movement, muscular coordination, and strength resulted from six weeks of weight training, as compared with six weeks of volleyball or inactivity. Measuring 600 men from 18 to 30 years of age, Zorbas and Karpovich (218) learned that the weight lifters were faster in speed of rotary arm motion than those who had done any weight lifting. Wilkin (212) tested the theory that weight training would have a slowing effect on speed of arm movement; he failed to support this when comparing nine experienced weight lifters, 19 beginning weight lifters, and 18 beginning swimmers and golfers, and also learned that a semester of weight training did not increase speed of movement more than did a semester of swimming or golf.

Four studies reported evidence that weight training improved motor coordination. In addition to the study by Masley and others (130), Calvin (25) compared two groups of 20 high school boys; one had four months of weight training while the others had a regular physical education program. The

experimental group made significant gains in four tests of motor coordination, while the control group made gains in only one area, and in three tests the experimental group made more gains than did the control group. With 23 college men, Kurt (119) obtained significant evidence that 12 weeks of weight training improved scores in hand-eye coordination, as well as balance and response time. At the end of eight weeks of weight training, Kusinitz and Keeney (120) found that 23 junior high school boys showed greater improvement in motor fitness tests than a similar group who were in regular physical education classes.

In swimming and basketball, the evidence has little significance. David (44) reported that 17 college men improved their speeds in the 25- and 50-yard crawl after nine weeks of weight training, but Thompson and Stull (195) obtained no improvement in speed for 30 yards as a result of six weeks of weight training. Clifton (33) divided a freshman basketball squad into two groups, and the experimental group had weight training for eight weeks. It was concluded that weight training did not influence the accuracy of shooting field goals.

Summary

The research on motor ability and motor skill development has presented some evidence to indicate superiority of athletes over nonathletes in motor ability, reaction time, eye-hand coordination, steadiness, and jumping ability. Although extensive, this research is not conclusive with respect to any one aspect, nor does it establish any cause and effect relationship. There is a small amount of contradictory evidence regarding the relationship between kinesthesis and motor learning; the same is true of motor ability and the learning of motor skills.

No conclusions can be drawn from the few conflicting reports concerning the relationship between strength and/or power and motor or athletic ability. Although many psychological studies support the hypothesis of transfer of training in motor skill learning, only two contradictory studies on this subject were found in physical education literature.

Most of the psychological research has indicated that distributed practice is superior to massed practice in motor learning. Studies dealing with physical education or athletic skills, few in number and scattered with respect to the particular activity, have obtained variable findings; thus no conclusions can be drawn at present.

Substantial evidence has been presented, both from psychological and physical education literature, to defend the statement that skill learning results from specific practice of the particular skill. A few contradictory findings, however, were found regarding the beneficial effects of related, unrelated, light, or heavy warm-up exercises on skill learning.

Only 23 studies were located to defend the supposition that skill learning takes place in regular physical education programs. This may be one of the most widely accepted hypotheses in the profession, and certainly needs a

great deal of supportive research evidence, especially for the general public and administrators. It should be noted, however, that 31 studies were seen to uphold the assumption that specific instruction results in skill learning. These were in scattered areas, and it would seem that much more research is needed in each aspect of physical skill learning with which the profession is concerned.

The findings with respect to the relative superiority of whole, part, progressive-part, and other methods of teaching skills are scattered and variable; it would appear that this is an area in which much research is needed. The same can be said regarding the relative effects of various other special methods of teaching; nothing conclusive has been developed from scientific research.

A fairly substantial number of reports defend the hypothesis that weight training exercises will increase the ability to perform vertical and broad jumps; there is a small amount of similar evidence regarding running speed, speed of movement, and motor coordination. With respect to arm and shoulder explosive power, the evidence is slight and conflicting. In only two specific sports, namely swimming and basketball, has any research been reported pertaining to the effect of weight training on skill development, and the findings have little significance.

Looking at the research cited in this review as a whole, there have been almost 400 studies reported during the past 30 or more years dealing with the contributions of physical activity to skill learning. Most of these have indicated that skill learning has resulted from some kind of physical activity. Thus we have evidence that the skill objective is being achieved to some extent, but most of the numerous subissues have inadequate support at present. More research is needed with respect to every hypothesis suggested in this review, and numerous other aspects of skill learning are still waiting to be explored (87, 98).

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The Contributions of Physical Activity to Growth

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Historical Background. The interrelationship of structure and function has been of concern to scientists for many years. A number of attempts have been made to unravel this relationship and to determine the primacy of one or the other. The theory of Lamarck propounded in 1773 stated not only that function of organs was improved by exercise of somatic muscles but that the creation of new organs and species occurred through protracted use of muscle groups. Almost a century later, Weismann established the continuity of the germ plasm and its comparative insulation from other tissues of the body. Thus each member of a species will inherit similar structure. This finding limits the role of function to ontogenetic rather than phylogenetic changes. It does not, however, clarify its place: to what extent does it serve as a stimulator and essential interactor in development?

The early part of the twentieth century saw extensive research in the field of innate versus acquired characteristics. In psychology behaviorists limited hereditary characteristics to those present at birth or shortly thereafter and attributed all further development to environmenal influences. Thus the individual was formed through function. This narrow interpretation of hereditary influence was refuted by Gesell (33), among others. In his observations of infant behavior development, Gesell recognized continuing influences of an intrinsic nature and he used the word "maturation" to describe the developmental process. No exact definition of maturation in this sense has been universally accepted, although the term itself is constantly used to describe changes which develop in an orderly fashion without direct influence of known external stimuli, but which are almost certainly, in part at least, a product of the interaction of the organism and its environment.

Exercise Stimulates Development. The method of co-twin control was used effectively by Gesell (34) to study the role of exercise in the development in infants of such actions as stair-climbing. The results have been interpreted quite widely as evidence principally of hereditary factors in maturation. The effects of exercise have been recorded, however, and should not be disregarded. In stair-climbing, the practiced twin was more agile, more skillful, and less fearful of falling than the control twin many weeks after the latter had succeeded in climbing the stairs.

McGraw (61) observed behaviors of human infants which reflected the development of neuromuscular mechanisms. Creeping, crawling, and loco-

motor activities were studied. She later used the co-twin control method in studying acquisition of a variety of motor performances. Climbing inclined boards, jumping from heights, and even roller skating were taught before the age of two. No amount of training was effective until a certain necessary stage of neural maturation was reached. Thus practice on the tricycle started at twelve months of age was continued for eight months before the child was able to perform this skill. At 22 months the untrained twin was equally skillful following very brief practice. The trained twin was superior in roller skating at 16 months. As practice was not continued, this skill was poor at three years of age.

Certain effects of this early training were still evident in follow-up studies four years later. The trained twin was more confident, performed with greater ease and skill. McGraw observed that "phylogenetic activities or those behavior patterns which every child must acquire in order to function biologically as a normal human being are more fixed and less subject to alteration of any significance by increased exercise. Activities of ontogenetic origin can be greatly accelerated through exercise" (61). Evidence from another investigator supports the latter observation. Mirenva (69) used four-year-old twins as subjects and trained one of each pair over a four-month period in jumping into the air, hitting a target with a ball, and bowling a ball. Training was given also in walking on a balance board and other activities designed to develop equilibrium, precision, and coordination. Although the control twins improved in the tests without specific practice, the amount of change was strikingly superior in the trained group. In addition, the latter became more active, more independent, and more disciplined.

A recent study (88) on gross motor development in infancy further supports the importance of activity. Two groups of Negro infants from sharply contrasting socioeconomic backgrounds were compared. The low group showed significant acceleration in motor activities. This result was attributed to a permissive atmosphere and absence of cribs, play pens, high chairs, and similar restrictive equipment in the low socioeconomic homes.

Deprivation of Normal Activity Inhibits Development. Further evidence on the role of exercise in early development of human infants has been gathered by Dennis (25, 26, 27, 28). He has observed the onset of motor behaviors in infants in different cultures where considerable restriction has been placed on activity during the first year. He has also experimented with limiting the stimulation permitted certain infants over a period of time (29). He observed that while maturation is a major factor in infant development, its importance lies chiefly in making learning possible. Maturation in and of itself seldom produces new developmental items, but maturation of structures when accompanied by self-directed activity leads to new infant responses.

Deprivation experiments on animals have been a fruitful source of study of the role of exercise or function in development. The excellent reviews of Carmichael (15, 16) may be consulted for early experimentation and method-

ology. Some recent work should be noted here, however. In experiments aimed at tracing the effect of early experiences on later behavior, a phenomenon called "imprinting" has been observed (40, 45, 46). Controlled experimental work in this field with mammals has just begun. Imprinting as defined occurs only during a critical growth period which in the animals studied apparently coincides with rapidly increasing locomotor ability (40). Imprinting seems to be a rigid form of learning in which the animal removed from his natural environment learns the general characteristics of the imprinting object. Gray (35), working with human infants, placed the critical period between six weeks and six months. Lowery (59) agreed with Gray in this timing since he found personality distortion to a greater extent in children who were institutionalized in early infancy than among those who entered at later ages. The implications of these experiments may be far reaching for an understanding of the influence of early experience on adult behavior.

The effects of complete absence of certain types of stimuli for a period of time provide another approach to the study of the relationship of early experience to later behavior (6, 53)). A chimpanzee reared in darkness for 16 months appeared totally unconscious of the visual environment when first brought out of the dark room (39). After weeks of living in a normal environment, he began to show signs of visual discrimination. He had to learn to distinguish visually friend from stranger, for example. Another study on a chimpanzee involved somesthetic perception (71). The animal was reared normally except that cardboard tubes were placed over the hands and feet in such a way that joint movement was possible but no exploration of the environment or self stimulation of the body could occur. This condition was maintained for two and one-half years. When the tubes were removed, grossly atypical behavior in sensory-motor performances was observed. A task involving somesthetic perception learned by a normal animal in 200 trials was not completely mastered in 2000 trials by the experimental animal. The chimpanzee never fully recovered from the effects of this restriction.

The effort to separate hereditary and environmental influences in development is no longer a fruitful one as abundant evidence has been gathered to show that behavior is dependent upon heredity, the supporting environment, and learning (2). Experience, largely motor, takes place in the intra-uterine environment. The neuromotor mechanism is capable of spontaneous behavior in advance of capacity to respond to the stimulation of sense organs (10). In a recent re-examination of studies on instinctive behavior, Schiller (77) has stressed the importance of motor action as a basis of learning. Studies on chimps indicate that the ultimate units of which adaptive patterns are composed are sensorimotor capacities developed through maturation and general experience. Meredith (67) believes that the inner world of man is built up to a great extent through movement and that all movements of infants and young children should be encouraged to the greatest possible extent within safety limits. He includes all locomotor and manipulatory movements as part of body action. A group of French psychologists (85) recently held a sym-

posium on the importance of movement in the psychological development. Piaget attested to the primacy of movement in concept organization. Others noted its role in providing experience and in making other experiences possible. It is inextricably bound up with all phases of development and personality.

Physical Size and Physical Abilities Increase Together

Changes in motor performances and motor capacities may be observed in growing children. The fact that older, taller, and heavier children are more capable of good physical performances than are their younger and smaller siblings is a common observation in everyday life. A number of excellent studies on age changes in physical abilities have been published. For the early years, Gesell (33), Shirley (82), and Bayley (5) have traced the course of development and identified motor patterns. Gutteridge (36) observed changing motor behaviors in preschool children. Hartman (38) and Jenkins (47) measured motor skills of kindergarten and primary grade children. Each of these investigators noted age changes and the orderly progression in improvement with age.

More recently Seils (79) measured a wide variety of motor skills of primary grade children. In analyzing age changes, he selected a very narrow range and did not find steady improvement with age in any of his events. Latchaw (58), with fourth, fifth, and sixth grade children, made a similar observation. She further noted that there appeared to be a maturity factor operating since same-age children in different grades performed at different levels. The work of Dimock (30) and of Espenschade (32) on adolescents showed that improvement in gross motor performances is closely related to physical growth, which in turn undergoes marked changes in rate near puberty. All types of events do not show the same identical pattern of change. Clearley (19) has recently completed an excellent study on age-height-weight-performance relationships in both boys and girls, ages nine through seventeen. Since he combined several performance measures into one score, it is impossible to study differences in developmental patterns among the several events. He does note, however, that the curve of growth in performance is not a linear one.

The increase of strength with size and maturity is especially evident and has repeatedly been demonstrated (31, 37, 50). Metheny (68) in 1941 reviewed studies on strength measures of preschool and elementary school children. The reviews of Bookwalter (8), 1950, and Hunsicker (41), 1957, in this *Quarterly* provide excellent bibliographies in this area. The work of Jones (50), using longitudinal data, has shown how close is the relationship between growth in standing height and increase in strength. The marked influence of puberty on both of these measures has been clearly shown. In both boys and girls, postpubescents are stronger than prepubescents of the same chronological age.

Several recent surveys should be considered here because they not only relate age to performance but demonstrate rather clearly the role of exercise

in improving the quality of performance. A number of studies using the Kraus-Weber test report improvement with age in the percentage of boys and girls passing the strength measures (13, 54, 55, 73). Because this is a minimum, pass or fail type of test, no information concerning changes in individual abilities with age is obtained. However, the widely different results obtained on various groups of children, together with changes brought about with relatively brief periods of training, highlight the role of exercise in optimum development.

The norms recently developed by the AAHPER (1) also show age changes in a variety of events. Although no directly comparable data from earlier times are available, some of the results are low in relation to all previous studies (21, 62). This is especially marked in strength measures. It seems reasonable to attribute this change to lack of practice in this type of performance. This survey, in common with most others which include girls above the age of 13, found a failure on the part of this older group to improve and even a tendency to make lower scores at older age levels. This is especially apparent in running and dynamic strength measures. There is adequate evidence to show that some of this decline is due to changes in interest and so to lack of practice or exercise. It is important that the necessary exercise for older girls be provided in activities of greater interest to them than running and jumping.

Asmussen and Heboll-Nielson (3) have recently attempted to discover factors underlying the interrelationships of growth and physical performance in children. On the hypothesis that geometrically similar boys should show similar performances, they related trunk length, chest circumference, height and weight to leg strength, as measured by leg extension strength, running in a steady state, vertical jump, and running during the initial phase of a sprint. They found that strength grows in different proportions to structure as measured. It increases more than is expected and cannot be explained on the basis of muscular growth. They offer maturation of the nervous system, possibly mobilization of effort, as tentative explanations. These same investigators (4) studied the influence of sex, age, and intelligence of Danish children 7 through 16 years old on the vertical jump and running speed. They found that the vertical jump increases with the body height in the same way for both sexes, but this is not true of running speed. Age apparently has a qualitative effect on performance, especially in activities requiring a high degree of coordination. The increased percentage of skill and neuromuscular coordination of older children cannot be accounted for by increase in size alone.

In spite of extensive study of interrelationships between physical growth and physical abilities, the available data permit only limited generalizations. Over a wide age range, performances increase with size up to about 14 years in girls and 18 or 20 in boys. The pattern of growth in all events is not the same (31). Because all gross motor performances improve with practice and strength increases with use, it is possible that the lack of control of the exercise factor in these studies has obscured the true picture of amount and

rate of change with growth. At very early ages, it may be assumed that all children have approximately equal opportunity for practice. This becomes increasingly less true with the years as interests change and multiple demands on time limit physical activity in varying degrees. Results of recent studies indicate that exercise or lack of it is an important variable in results obtained. The factors underlying interrelationships of growth and performance have not been fully identified.

Physique and Physical Performances Are Interrelated at All Ages

Factors other than rate of growth are important in physical performances. The shape of the body, determined largely by heredity, plays a major role. Extensive studies of the relationship of age, height, and weight to performances of boys and girls and the optimum combination of these factors to equalize the size factor in competition or achievement resulted in classification plans currently in use. The early work of Bliss (7) and Reilly (75) led to the development of the McCloy (62) and the California (Cozens) (20) classification indexes. It was recognized that maturity, apart from absolute size, was a factor especially for adolescent boys, but no practical way of including it in these plans has been proposed.

The use of the Wetzel grid (86) as a classifier for growing children has been proposed but not widely adopted. When both physique channel and developmental level were used for grouping boys, a substantial relationship with performance on the Indiana Physical Fitness Test was shown (9). Thin and medium boys in general tend to perform better than large or obese boys.

The Kraus-Weber tests, especially the flexibility measurement, have led to several investigations on the relationship of build to performance. Mathews and others (65) took three anthropometric measurements of body lengths and gave three flexibility measures to women. No significant relationships were found. Broer and Gallis (11) reported no relationship for women of average build but did find significant differences for extreme builds; for example, those showing extremely long trunk plus arms measures with short legs had an advantage in bending over and touching fingertips to the floor without bending the knees. Tyrance (84) collected data on the fattest, thinnest, and most muscular male students at Pennsylvania State University to investigate the relationship of these extreme body types to flexibility of neck, elbow, knee, and hip joints. He found neck flexion to be the most significant somatotype variable in the prediction of flexibility. In still another study of Kraus-Weber results, Shaffer (80) tested some 1400 junior high school girls. The tall-overweight girls failed less frequently in flexibility before conditioning but had a high percentage of strength failures. A good calisthenics program for a semester reduced rate of failure of all children below that reported for European children.

A number of studies on relationships between strength and physical abilities and selected anthropometric measures have been published in the last few

years by Clarke (17, 18). Subjects have been elementary and high school boys and college men. For the latter, body weight and adipose tissue measurements showed the most significant relationships with performance. Correlations between performance and adipose tissue are negative. The relationship between structural and strength measures were higher for boys at all school levels than for college men. They are not high enough for predictive purposes, however. Factors other than structure are important in strength.

Correlations between ankle extensor strength and measures of leg muscle size have been reported by Rarick (74) for seven-year-old boys to range from .58 to .63, and for girls, .22 to .52. The author matched boys and girls on measures of muscle size and found that boys exhibited on the average greater strength than girls, but this superiority was significant only at the 30 percent level of confidence. Further investigation is needed to establish a qualitative sex difference in muscle tissue.

The Sheldon (81) scheme for body typing appears to have provided a more valuable tool for the study of structure-function interrelationships than has any selection of anthropometric measurements or indexes derived from them. The close relationship between physique and performance can readily be observed in animals. In horses, for example, selective breeding has produced the race horse and the dray horse, two distinctly different types with markedly different capacities. The development of "pure" breeds has made possible the continuation of special strains. In man, wide diversity and heterogeneous mating rarely produce extreme or distinct body types. It has been shown, however, that particular combinations of physical characteristics are desirable in athletes. Furthermore, the types best adapted to certain sports are not always those most suitable for others. Cureton (23) has reviewed some of the earlier findings and has contributed substantially to knowledge in this area through investigation of body types of college and Olympic athletes.

The Sheldon classification yields a numerical score of three numbers, each of which indicates the rating on a seven-point scale of a particular component in the body. These components are named endomorphy, mesomorphy, and ectomorphy and may be described briefly as fat, muscular, and thin. Very seldom do men or women low in mesomorphy succeed in athletics. Track athletes are slim in body and combine mesomorphy with considerable ectomorphy. In aquatics, a combination with endomorphy is more usual.

Strength in boys is closely related to the mesomorphic component (50). So too is rate of growth, as mesomorphy is associated with early maturity (42). Willgoose (89) found scores on Roger's PFI test related significantly to mesomorphy. Among college men, mesomorphs not only are the strongest but also excel in agility, speed, and endurance (83). Endomorphs may be stronger than ectomorphs (static-strength measures), but ectomorphs are superior in agility, speed, and endurance.

Seltzer and Brouha (78) developed a rating plan for men on what they called the "masculine component." They found a high degree of relationship between the strength or degree of masculinity and fitness for hard muscular

work. They found that superior fitness could only be achieved by subjects with a strong masculine component. The weaker the masculine component, the greater the frequency of poor fitness. The "masculine component" as described by these authors is very closely related to Sheldon's mesomorphy.

The Sheldon scheme has been adapted for women. Approximately 600 women, including 90 physical education majors, at the University of Illinois were somatotyped by Sheldon or assistants. Tests of agility, flexibility, strength, and power were given to this group by Perbix (72). Results showed that the physical education major group tended more toward mesomorphy than did the group as a whole. In the majority of women, the endomorphic component was dominant. Relationships between physique and performance were lower than those reported for men, but some significant correlations were obtained. Mesomorphy was related positively to power and to strength.

Cureton included women athletes in his studies of physique of champion athletes. In this group, the endomorphic component is also quite marked. When a scheme of typing based largely upon a pattern developed for men is used, it is not surprising that this finding should appear.

The evidence from studies on physique points to the fact that certain individuals are literally built for action and, furthermore, built for certain types of action. It should be re-emphasized, however, that human beings do not fall readily into clear-cut types, nor is physique alone the most significant factor in performance. It may be true that a "good big man" is better than a "good little man" in many sports but being big is less significant than being "good."

Exercise Does Influence Growth

The primary role of heredity in morphology has been affirmed repeatedly. Within these limitations, however, function plays a constant and vital role in every area of ontological development.

Recently, at the University of Gothenberg, physiologists have found changes due to exercise in the bones and connective tissues of animals (44). A series of experiments has demonstrated an increase in thickness of connective tissue which is accompanied by greater tensile strength. The cartilage which covers the articulating surfaces of bones shows greater thickness and compressibility. The bones themselves increase in amount of mineral salts present. These changes are all directly related to exercise and are lost if exercise is reduced or discontinued.

Exercise plays an important role in weight control or reduction. Experiments conducted at the Harvard School of Public Health show that exercise helps both mice and men to maintain normal weight (66). Furthermore, they demonstrate that weight reduction through exercise can be brought about in rats even though they are permitted to eat all they wish. Cureton (24) and students have found a rise in basal metabolic rate in people who are trained hard for a fairly long period of time. Fat reduction in significant amounts can be demonstrated in people participating in hard training programs. Exer-

cise affects blood cholesterol levels, also. Subjects taking daily exercise maintained improved levels of cholesterol whereas reducing by food reduction only returned cholesterol to the original levels. The findings in this whole area were reviewed by Cureton (24) in a presentation to the American Academy of Physical Education. They are reviewed also by Hein and Ryan in this supplement.

Changes in muscle as a result of exercise have long been observed. Textbooks of exercise physiology discuss this process in some detail and will not be repeated here (52, 70). Recent interest in physical education on the effects of weight training have stimulated research in this area. At the same time, heavy resistance exercises have been proposed as a means of increasing strength rapidly in rehabilitation. Experimentation in relation to rehabilitation is discussed elsewhere in this volume.

A series of reports in this *Quarterly* has established some facts concerning weight training. Evidently this training does not reduce speed of muscle movement but actually tends to increase it (14, 63, 90). Results concerning reduction of flexibility from muscle development in weight training are less conclusive (57, 64). Some loss may occur as strength increases. Changes in anthropometric measurements of adolescent boys as a result of weight training have been reported by Kusinitz (57). Weight and waist girth declined whereas all other girths increased significantly.

In relating exercise to changes in physique, strength, and efficiency, several other studies should be mentioned. In South Africa in the thirties, a large group of unemployed youth were assigned to a Special Service Battalion, for physical training (49). A sample were given extensive tests during a six-month period. Improvement occurred in all areas. Weight, posture, and chest girth increased markedly. Height increase was not significant and was attributed to postural improvement.

In 1933, Rowe (76) reported that nonathletes grew more in height and weight than athletes during a school semester. Recently McCraw (60), using better matching techniques, obtained a contrary finding. Since athletes of junior high school age tend to be more mature than nonathletes (56), it is probable that they are growing less rapidly. Whether athletics actually influence growth in height is questionable. Changes in girths are to be expected (22). Improvement in all physical abilities, such as strength, speed, power, and coordination, is significantly greater in athletes than in nonathletes.

In another report, Jokl (48) compares the physiques of twin men, one of whom had had consistent gymnastic training, while the other had not. The trained twin was stronger and heavier and had broader shoulders than his partner. This difference in participation in physical exercise resulted in major functional differences but in only minor structural changes. Morehouse (70) has also noted the effects of exercise on physiques of athletes.

Recently a study comparing right and left arms of tennis players and of soldiers has been published (12). In both groups, hand width, wrist width, and forearm circumference differed. In tennis players, slight increases in

length of radius, ulna, and distal ulna width were noted in the preferred arm. Strength differences were evident in both groups but were greater in the tennis players.

This group of studies contributes experimental evidence of the important role of exercise in growth of bone, tissue, and muscles. That exercise also helps to shape the individual is substantiated.

Summary

No student of physical growth can ignore the important function of heredity in determining structure. At the same time, the evidence supporting the vital role or function of exercise in optimum development is steadily accumulating. From conception on, heredity and environment interact to shape the individual. Experiences immediately after birth influence later behavior. Exercise of all sensory and neuromuscular functions is essential for so-called normal development.

Growth in physique and in physical abilities occurs simultaneously, but exercise is certainly a limiting factor in increase in abilities. Physique appears to limit physical performance but in turn is influenced to some extent by the amount and the type of exercise performed.

Desirable changes in bones, connective tissues, fat, and musculature occur as a result of exercise. These changes are not necessarily permanent but are dependent upon continued activity. More lasting changes in structure almost certainly result from long continued specilization.

Exercise, then, stimulates growth of body and makes the individual stronger and more capable of efficient function.

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The Contributions of Physical Activity to Rehabiliation

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MEDICAL REHABILITATION is defined as a process designed to prevent or reverse the deleterious effects of inactivity, to minimize disability, and to train the individual with residual permanent disability in the techniques of overcoming handicap (12). A common denominator in many illnesses is the debilitating effects, not only of the disease process itself, but of the therapeutic use of inactivity, bed rest, and immobilization. A few among these effects are bone atrophy, reduced efficiency of the circulatory apparatus, and reduction in strength of muscle contraction.

From the clinical point of view it has long been recognized that exercise can be beneficial to the organism and that there is a specificity of effect depending upon the form of exercise used. As a result, exercise was and is being prescribed in an empiric way in order to produce the desired effect. A critical review of the recent research literature reveals that this empiric approach can often be questioned. Three forms of therapy selected to be questioned are:

1. The use of standing and ambulation to prevent or reverse disuse atrophy of bone.
2. Postural exercise to increase blood flow in peripheral arterial disease.
3. Progressive resistance exercise to maintain or increase muscle strength.

An attempt will be made to show that although logical in conception, these empirically derived forms of therapy often fall short of complete effectiveness. With increasing knowledge, it is now becoming possible to prescribe therapeutic activity with greater accuracy and precision.

Effect of Exercise in Preventing Bone Atrophy

Immobilization of the skeleton leads to bone atrophy. Albright and his coworkers (4) are the most frequently quoted authorities for the statement that such atrophy can result from the loss of "stress and strain" placed upon bone. They stated that "two common causes for cessation of bone formation are immobilization of the skeleton in a cast or freeing of the skeleton of muscle pull as a consequence of poliomyelitis." This idea was previously summed up in Wolff's law of the transformation of bone (44). The law stated that every change in the form and function of bone or of its function alone is followed by certain definite changes in its internal architecture and secondary alterations in its external configuration. The trajectorial theory of Koch (29) related the direction of trabeculae, their thickness, and number to the pressure

and tension forces exerted upon bone. There has been a good deal of controversy concerning the validity of this hypothesis since some have denied that the trabeculae were arranged precisely enough to resist only pressure and tension stresses (26). Others felt that while this mechanical explanation was applicable to bones as isolated structures it did not give due regard to the forces applied by contracting muscle (37). Jansen (26) stated that the compressing forces upon bone produced by contracting muscle were more important than those due to body weight. He discarded tension as a cause of bone formation. In summing up the evidence for the mechanical relationships of bone formation, Bell (7) stated that although the evidence was not conclusive, on the whole it favored the idea that compression stimulated osteogenesis.

There is little doubt that bone structure is admirably adapted for function, that it rarefies when function is lost, and is formed when function is re-established. It is also evident that the size of growing bone is at least partially determined by function, since bones remain small with reduction of such function as is the case in extensive paralysis (22). The external shape of bone may be altered during growth occurring in the presence of paralysis since bony ridges for tendinous attachment do not develop to normal size and the cross-sectional shape of certain bones such as the tibia may change (19).

Metabolic studies have confirmed the relationship of bone rarefaction and formation to the forces applied to it (11, 15). The negative nitrogen balance which is a characteristic finding in disuse is said to reflect continuing protein catabolism in the presence of reduced protein anabolism. Since protein occurs in almost all tissues, a study of nitrogen balance is a study of total body protein change. The amount of calcium in bone is thoroughly dependent upon and reflects the amount of protein bony matrix (osteoid), and the total body calcium lies largely within bone. Because of this a study of the relationship between calcium intake and output clearly reflects change within the skeleton. Thus the process of bone atrophy will increase calcium excretion in the presence of relatively constant daily calcium intake. When a normal individual is immobilized the output of both nitrogen and calcium rises; when function is re-established the output falls back to normal (11). While this statement is true in general it tells us little about the effect upon bone of the kind of inactivity produced by disablement. It tells us even less about the kinds of activity which will prevent or reverse such losses. Because activities such as exercise and ambulation are the most widely used therapeutic tools in rehabilitation it becomes important to determine whether these or other activities are capable of preventing bone loss. Since rapidly occurring bone atrophy is accompanied by an increased output of calcium in the urine and since high urinary calcium concentration is a major factor in the formation of urinary calcium stone, the importance of determining the validity of any form of therapy designed to prevent atrophy becomes even more apparent.

There are many causes of bone atrophy and hence there are many kinds (6). The kind caused by loss of "stress and strain" is known as osteoporosis. Its outstanding characteristic is that the ratio of protein bony matrix to cal-

cium content remains the same no matter how dense or atrophic the bone may be. This is explained by the fact that bone protein undergoes constant building up and breaking down and that this protein binds calicum in a fixed proportion. If protein is not built up at a normal rate or is broken down at faster than a normal rate, calcium content of bone is that much less and the excess calcium is excreted. These conditions hold in protein deprivation as occurs in starvation and by the direct effects on protein of hormone and vitamin excess or deficiency. Thus the excessive pituitary or adrenal cortical hormone secretion of Cushing's syndrome, the steroid treatment of arthritis, gonadal hormone deficiency as occurs following menopause or in aging, and insulin deficiency as in diabetes or thyroid hormone excess as occurs in Graves' disease all may cause osteoporosis. Vitamin C deficiency as in scurvy also leads to this form of bone atrophy through the loss of its effect on maturing the osteoid (6). Thus there are many causes of osteoporosis besides the loss of "stress and strain." There is a fertile field of investigation into the interrelationship of the effects of each of these factors in bone loss and bone preservation. There are also many methods of treatment depending upon cause. Sometimes these methods cross over as in the attempts to treat bone loss by sex hormone when the cause is most likely that of disuse. That this method leaves much to be desired may be due to difference in causation. Our present concern is with that form of osteoporosis resulting from inactivity and immobilization, often a common denominator in many pathologic states.

The pattern of calcium loss from a variety of conditions such as in plaster immobilization of normal young men, fracture of a lower extremity bone, or in extensive flaccid paralysis as in poliomyelitis is much the same (11, 15, 25). However, the urinary calcium output is half again as high in the fracture cases as in immobilization of the normal individual and somewhat higher still in cases of poliomyelitis. While all are relatively immobile it is obvious that in these three conditions, immobility is in increasing order of magnitude. One group of investigators held that both the size and duration of the calcium loss increased with increasing degrees of paralysis, while another group confirmed the proportional relationship of only the duration of calcium loss with degree of paralysis (14, 15, 41). Such losses lasted throughout the 6 or 7 weeks of the immobilization experiment in normal young men, from 8½ to 14½ weeks in the cases of fracture following which calcium output began to fall, and from 18 to 52 and occasionally more weeks in cases of poliomyelitis, depending upon the degree of paralysis (11, 15, 25). It is interesting to note that despite the lack of re-establishment of any kind of activity, there is a tendency for bone to develop a new metabolic balance with the passage of time.

Nitrogen losses tend to occur more quickly and to recover more quickly than those of calcium (11, 15). This may be related to a greater lability of nonskeletal protein. Disappearance of bone due to the most prolonged immobilization is unknown. It may be that during depletion a point is reached where calcium is more tightly bound or more likely the final reduced density

of bone is suitable to the reduced level of activity. It is hard to conceive of conditions in which there is absolute lack of activity and therefore no stress. With this knowledge of the similarities and differences between the calcium losses occurring in the normal and in some abnormal conditions it becomes possible to evaluate with the same kind of studies the changes which may result from the application of various forms of therapeutic stress.

Abramson (1) studied the effect of ambulation on the prevention of bone atrophy in paraplegia due to injury to the contents of the spinal canal. Some of his patients were flaccid and some spastic in their paralysis. Soule (35) had stated previously that the radiologic appearance of osteoporosis occurred both in spastic and flaccid paralysis. In a radiologic study of more than 50 cases Abramson concluded that ambulation prevented osteoporosis and secondarily calcium urinary stone. His studies were done on patients who had no recovery of voluntary muscle power and were from one to two years beyond their onset of paralysis. This differed from other studies which were usually done well within the period of maximum calcium loss. Freeman (20) reported, again within the period of maximum calcium loss, that ambulation and even standing caused a drop in calcium output. This can be questioned since he did not measure the calcium intake and calcium output was determined by a quantitative Sulkovich test in which there are inherently many potential errors of technique and interpretation. At this point there was a widespread advocacy of ambulation with crutches and braces and of standing as therapeutic methods of re-establishing calcium balance and thus of preventing bone atrophy and its complications in cases of paralysis.

The effects of another therapeutic agent were investigated by Whedon, Deitrich, and Shor (39). They found that placing plaster-immobilized normal young men in an oscillating bed would cause a fall in introgen and calcium output but that this fall was not quite back to a normal level. This effect was not apparent in patients with extensive paralysis due to poliomyelitis (40). They felt that weight bearing against the plaster in the feet down position was a stress factor in both cases, even though very much less than in the upright standing position. This stress factor was obviously not enough to preserve bone in the absence of contraction of muscle caused by postural changes.

The effects of the oscillating bed and standing upright in a tilt table were studied by Wyse and Pattee (45) in a small number of paraplegics. In previous studies they had established as in other types of paralysis that paraplegia is followed by disuse osteoporosis, hypercalciuria, and negative nitrogen balance (46). They could demonstrate no significantly favorable effects attained through the use of these therapeutic modalities since there was occasionally little and often no lessening trend in either nitrogen or calcium output. They stated that at least the weight bearing portion of the "stress and strain" triad of weight bearing, circulatory changes in bone, or muscular pulls on bone was not evident. Both they (45) and Whedon and Shorr (40) demonstrated that circulatory changes in the lower extremities in terms of loss of vascular tone were largely prevented by the oscillating bed or the tilt table.

Therefore they concluded that "stress and strain" upon bone might primarily result from muscular contractions.

These findings were similar to those of Plum and Dunning (32) whose metabolic balance studies were done on patients with varying degrees of paralysis due to poliomyelitis. No significant fall in calcium output was seen in patients who were rocked on a tilt table or activated by exercising under water, by sitting in a wheelchair, and by ambulation with crutches and braces. A patient who could ambulate with canes, even though he wore some braces, did show a significant fall in calcium output. Ambulation with canes requires enough recovery of muscle to enable the individual to maintain balance and to ambulate with a four point gait. The difference in functioning muscle mass required to do this as compared to crutch and brace ambulation is considerable. These short-term studies during the period of maximum calcium loss would tend to confirm the view that the forces applied to bone by contracting muscle is the most or perhaps only effective means of preventing bone atrophy due to disuse. It is reasonably certain that muscular contraction is a potent force in preventing bone atrophy. The recovery in normal young men after reinstitution of normal activity would indicate that muscle contraction had been instrumental in that recovery if weight bearing is not an important factor.

Calcium losses can sometimes be reduced in the case of bone atrophy occurring in rheumatoid arthritis by the use of resistance exercises (10). Geiser and Trueta (21) demonstrated that bone rarefaction occurred in the rabbit following tenotomy, immobilization in plaster, and osteotomy followed by internal and external fixation. They also demonstrated that bone rarefaction could be reduced by electrically stimulating muscle to contraction while immobilized in plaster or by removal of the plaster allowing normal activity.

That weight bearing has a favorable effect on the prevention of bone atrophy despite previously mentioned mechanical and clinical evidence has been brought into serious question.

There tends to be a quantitative relationship between reduction of muscle pull and calcium loss from bone. Thus calcium losses from tuberculous adolescents at bed rest but otherwise unrestrained are negligible (27). It becomes significant in young men at bed rest restrained by plaster spica fixation but without disruption of nerve-muscle-bone continuity (11). It is greater still in more limited plaster immobilization for tenotomy or fracture of a single leg bone (25). It is greatest of all in paralysis of multiple muscle groups (15). It is apparent that muscular activity is in decreasing order of magnitude from unrestrained bed rest of the normal to the complete disability of the tetraplegic paralytic. If after a while the daily calcium output does not seem significantly greater despite increasing degree of paralysis, the duration of such calcium losses is proportionately greater (15). In all of these pathologic states there is also total loss of weight bearing. Despite this, calcium losses differ.

Therapeutic responses in terms of decreased calcium loss are also related to re-establishment of muscle function and apparently not to the re-establishment of weight bearing alone.

Longitudinal compression of bone is admittedly only one type of stress. Muscular pulls, even if they do compress bone as demonstrated by Geiser and Trueta (10) and Jansen (26), also produce torsion, shearing, and bending forces acting on bone. Thus a great enough degree and variety of stress seems necessary to preserve bone. In a brief study on a patient with severe spasticity, Wyse and Pattee (45) found normally low daily excretions of calcium. But in another patient with only mild spasticity, calcium output levels were elevated. In view of the evidence, weight bearing does not develop sufficient degree and variety of stress while muscle action of sufficient magnitude is apparently capable of producing enough of both. According to this concept, weight bearing should have therapeutic usefulness as one form of stress although by itself it is insufficient for metabolic usefulness. To be added to this is the established usefulness of standing and ambulation in maintaining or re-establishing vascular homeostasis. Vigorous crutch and brace ambulation may also have a positive effect on the metabolism of the uninvolved parts of the body.

Effect of Exercise on Peripheral Arterial Disease

Arterial disease may restrict the flow of blood to a limb. Such disease, being often chronic and progressive in nature as in arteriosclerosis, threatens the function and ultimately the life of such a limb. Therapeutic efforts, whether surgical, chemical, or mechanical, are designed to increase blood flow and thus prolong limb function and life. Exercise is considered an important therapeutic modality toward achieving this end.

Blood vessels are said to vary in size depending on the degree of chronic demand for blood. Thoma (36) demonstrated that vessels in an amputation stump had a narrowed lumen and explained this on the basis of decreased blood flow caused by loss of blood demanding tissue. Where an artery was occluded, collateral vessels hypertrophied in desponse to tissue demand for blood (31).

For many years Buerger's exercises were extensively used, as they still are today, in order to increase blood flow in cases of arterial disease (31). These are passive postural exercises done according to a fixed ritual. In summary, the lower extremities of a supine individual are passively elevated and maintained in this position for a short period. This is followed by the legs being hung down over the edge of the bed for another period and then having the legs placed horizontally for a third period. This cycle is repeated many times a day. The blanching on elevation and the rubor on dependency are supposed to indicate alternate emptying and filling of vessels which by their mechanical effect would increase the blood carrying potential of these vessels through increasing the size of the lumen of arteries and their collaterals. Allen, Barker, and Hines (5) expressed surprise that a method of treatment without the slightest physiologic evidence for its claimed effectiveness was so widely used.

Wisham and his co-workers (42) then demonstrated that radioactive sodium (Na^{24}) was not significantly cleared from muscle at faster than rest rate

in performing Buerger's exercises in normals and in individuals with occlusive arterial disease.

Although the quantitative relationship between rate of clearance of radiosodium from muscle and blood flow has not been established, there seems little doubt that increased blood flow increases rate of clearance (28, 43). Thus, physiologic evidence is available that Buerger's exercises are relatively ineffective. There is some evidence that passive postural exercise can have a favorable effect on peripheral circulation. This effect, however, is on vascular tone and not upon blood flow.

Following the use of the oscillating bed in which the lower extremities are alternately lowered and raised, it has been demonstrated that re-establishment of the upright posture is not followed by faintness and syncope (39, 40, 45). The latter phenomena are attributed to loss of vasomotor tone with pooling of blood in the lower extremities resulting in cerebral ischemia. This loss of tone occurs in prolonged bed rest and immobilization both in the normal and in the individual with extensive paralysis (11, 40, 45). In either case it can be prevented by the consistent use of the oscillating bed or the tilt table.

By plethysmographic methods, Abramson (3) showed that vigorous exercise can increase muscle blood flow eight or more times resting value in the normal individual. Wisham (42) found that the rate of radiosodium clearance increased in proportion to the degree of exericse, being greater in active exercise than at rest and greater still in resisted exercise. A partial effect of the exercise in terms of increased blood flow was still apparent five minutes after the cessation of such exercise. This was found in the normal and to a lesser but still significant degree in the individual with peripheral arterial disease. Ebel (16) felt that this principle could be applied by using walking to the point of intermittent claudication as a form of treatment. This creates a maximum demand on circulation and thus maximum stimulus to collateral vessel development.

Blood flow in limbs is unresponsive to exercise in which muscles do not contract (passive exercises). It is most responsive to exercise which is most forceful. This is true in the normal, and it is equally true in the patient with occlusive arterial disease.

Effect of Exercise on Developing and Maintaining Muscle Strength

Immobilization, either general or local, results in a decrease of muscle bulk and strength. Deitrich, Whedon, and Shorr (11) demonstrated that in immobilization of normal individuals in body spicas for periods of six to seven weeks there was an average nitrogen loss of 53.7 grams which they equated to 1.7 kg of muscle protoplasm. Ergographic testing during this period showed significant loss of strength when compared to control values. Studies on local immobilization have been carried out using skeletal fixation in plaster, tenotomy, and neurologic isolation (9, 17, 18, 33 38). All of these confirm the need for muscle contraction to maintain its strength and bulk and tend to validate the rehabilitation concept that unnecessary immobilization is to be

avoided. Although restoration of the patient with loss of muscle strength has been sought through specific exercise, there are some who feel that the resumption of ordinary activity by the patient is all that is necessary to restore musculature to adequate function. That this is not so is borne out by the frequent findings of atrophy and weakness of the quadriceps muscle, in patients who had had their knees arthrotomized, many months after the period of relative immobilization was over (2).

The use of active exercise to restore strength of muscle is generally accepted, but there is no such unanimity as regards the specific type of exercise which will produce the most favorable result in the shortest time.

In 1945 Delorme (13, 14) published his empirically derived scheme of progressive resistive exercise for increasing muscle strength. Since then there have been a number of studies challenging the method and proposing less elaborate and possibly more efficient ways of obtaining the same result. Hellebrandt (23) criticized the Delorme method because in her opinion he attempted to obtain maximum performance without attaining an overload. Such overload can be attained by increasing either rate and/or resistance.

In 1953, Hettinger and Muller (24) reported on the then rather startling fact that muscle strength could be increased in normal individuals by brief isometric exercises consisting of one maximum effort contraction daily, maintained for two to five seconds.

In 1957, Rose and co-workers (34) reported on the effect of one daily five-second isotonic contraction of the quadriceps in 28 normal adults and in 46 adult patients with quadriceps weakness from a variety of causes. With this method of exercise there was an increase in strength in daily increments of 1¼ lbs., regardless of the initial strength of the muscle tested. The final increase in strength varied from 80 to 400 percent of the original value. The authors concluded that the overload principle applied to brief maximal exercise. In 1959, Liberson and Asa (30) reported on the effect of brief isometric exercise. They compared this effect to that obtained by the Delorme method and concluded that brief isometric exercise resulted in a more rapid increase in strength. They also concluded that repeated isometric contractions resulted in a more rapid increase in strength and greater increase in endurance than the single isometric contraction.

The studies of Rose and others (34) and of Liberson and Asa (30) did not show a concurrent increase in muscle bulk comparable to the increase in muscle strength. However, it must be emphasized that there is no satisfactory method of measuring muscle bulk in the living human subject.

Although progressive resistive exercise, being of slow tempo and less than maximally loaded, does increase muscle strength, the application of the overload principle may be more effective and certainly less time consuming.

Summary and Conclusions

1. Three forms of commonly used therapeutic procedures have been evaluated from the point of view of newer information in the research literature.

2. Muscle contraction is necessary to prevent disuse atrophy of bone. Such muscle contraction has to be sufficiently forceful.

3. Muscle contraction increases blood flow in the normal and in the patient with occlusive arterial disease. The more forceful the contraction, the better the effect.

4. Overloaded muscle contraction is the most efficient in increasing muscle strength.

5. As a general principle, concepts of therapy developed through investigation must replace, modify, and refine those which are empirically derived.

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AAHPER'S SCIENTISTS

A Report of the Activities of the Research Council

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New York University

THE RESEARCH COUNCIL'S purpose is to stimulate research in health, physical education, and recreation and to advance knowledge in these special fields.

It is a section of the General Division of AAHPER and elects its president, secretary-treasurer, and a member-at-large to AAHPER's Representative Assembly. Standing committees are appointed to take charge of the Council's many projects; a chairman has administrative responsibility for each.

Unlike most sections of AAHPER, the Research Council elects its members and periodically reviews each member's activities. Only professional members of AAHPER who have published research, reported research at professional meetings, and regularly attend research meetings are eligible for membership. Those members who do not remain active are dropped.

The Council sets no limits to its size; any member of AAHPER who meets the eligibility requirements may be elected to the Council. A membership committee annually combs the field for eligible persons, and often persons apply for membership. Yet the present membership stands at only 103 persons, a number probably close to the potential. Admittedly, the Council is exclusive, but not for the purpose of self-aggrandizement. Strict qualifications are necessary if members are to perform the activities of the Research Council. Without the technical skill and research ability of present members, Council projects would never be completed or would be inferior. Because the members of the Research Council are highly trained in their fields of specialization and in research, they can give valuable service to the profession and to AAHPER, as illustrated by the following activities. Six types of service are listed.

Initiate Cooperative Effort for Research along Strategic Lines

Some research projects are so long that only a team of workers can hope to complete them. An example is the Youth Fitness Test and accompanying national standards developed recently under the joint sponsorship of the Research Council and AAHPER. This project was immense, and a team of research workers was called upon to plan and carry out the study. At the outset, these researchers faced an obstacle to large-scale adoption of a test, namely, divided opinion as to the best instrument. However, they submerged their individual opinions in favor of a unified effort so that one test could be

selected. Through the cooperative work of this group, AAHPER has taken a giant step forward in developing national standards for physical education.

Develop Long-Range Research Plans on Problems Vital to the Advancement of the Field as a Science

AAHPER hopes to sponsor a major experimental study to determine how much an ideal physical education program influences boys and girls throughout their school years. When this project starts, it will be planned and carried out by the Research Council. This year, the Council takes the first step by using the findings of published research to construct an ideal physical education program. This ideal program was introduced to the members of AAHPER at the 1960 convention in Miami Beach.

When the experiments finally get under way, students in laboratory schools will participate in this theoretically developed program under properly controlled experimental conditions. It is hoped that the findings will demonstrate the worth of physical education and provide a scientific basis for planning programs.

Prepare and Disseminate Materials to Aid Research Workers

The Research Council has several projects under way, some continuously, to produce materials for research workers.

1. For several years, annual bibliographies of published research in physical education, health education, and recreation have been compiled and distributed to members of the Research Council. Abstracts of graduate studies were also compiled and published. This year for the first time these two services are combined in a report of completed research in physical education, health education, and recreation. This compilation will be made annually.

2. Members of the Research Council prepare abstracts of published research in allied fields. These abstracts appear in each issue of the *Research Quarterly*.

3. In 1948, a group of Research Council members collaborated to prepare a textbook entitled *Research Methods Applied to Health, Physical Education, and Recreation*. This year, a revised edition of this very popular reference has been published.

These publications projects have been carried out under the sponsorship of the Research Council with the support of AAHPER funds.

Synthesize Scientific Knowledge Applied to Special Areas in the Profession

This year, a member of the Research Council is preparing a report to be called "What Research Tells the Coach about Baseball." He will review the research literature in baseball and organize the material into an informative report, written in nontechnical language. Coaches can use it as a handy source of authoritative information about sports techniques and teaching methods, based upon research findings.

RESEARCH COUNCIL OFFICERS, 1960-61

RAYMOND A. WEISS
Past-Chairman

M. GLADYS SCOTT
Chairman

J. GROVE WOLF
Secretary

It is the purpose of research to advance knowledge, and it will be the purpose of this sports synthesis to interpret scientific knowledge to coaches. The Research Council plans to prepare a series of reports on what research tells the coach about various sports. Ahead lies the task of interpreting research findings to teachers in health education, teachers in physical education, and leaders in recreation.

Represent the Association in Cooperative Relations with Other Research Organizations

During this past year, the American Educational Research Association sponsored the formation of a Council for Research in Education. The major purpose of this new organization is to strengthen research activity in educational organizations through cooperative effort. AAHPER's representative to the Council for Research in Education is the past-president of the Research Council.

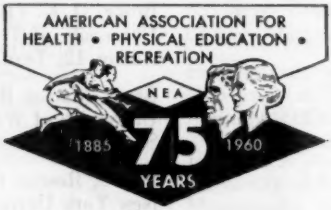
Sponsor the Research Quarterly

As one of its most important services, the Council strives to increase the quality of the Association's research journal, the *Research Quarterly*. The Council develops criteria for accepting articles for the *Quarterly* and sets standards by which the *Quarterly's* associate editors are chosen. Associate editors are members of the Council who are chosen by their peers for ability to judge the quality of research reports.

Provide Advice to Other Divisions of AAHPER

This year, two sections of AAHPER have asked the Research Council to assist them in preparing reports summarizing research in their special areas. Committees of the Council have undertaken reviews of the research literature in these special areas and presented their findings at section meetings during the 1960 AAHPER convention in Miami Beach.

This year the Research Council has formed a resource committee of persons who can offer research advice to the various sections of the Association. All sections have been invited to avail themselves of this consultation service. The special competencies and interests of the consultants have been catalogued, and requests for advice will be referred to the appropriate persons. Members of AAHPER who wish advice about research problems are invited to use this research service. Inquiries may be directed to Raymond A. Weiss, chairman, AAHPER Research Council, New York University, Washington Square, New York 3, New York.



Research Council of the American Association for Health, Physical Education, and Recreation

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The Research Quarterly

The Research Quarterly of the AAHPER is a technical periodical reporting research studies in the fields of health, safety, physical education, athletics, and recreation. It is unique in its coverage. Published in March, May, October, and December, the *Research Quarterly* goes to graduate students and professors throughout the United States. It is available to individuals with membership in the American Association for Health, Physical Education, and Recreation, and to libraries and institutions upon subscription of $3.00 per year. Single copies $.75.

Other Research Materials

RESEARCH METHODS IN HEALTH, PHYSICAL EDUCATION, AND RECREATION

Principles and methods of conducting research in these fields. Basic text and reference for graduate research methods. Second edition, 1959. 486 p., $6.00.

MEASUREMENT AND EVALUATION MATERIALS

Prepared by the AAHPER Research Council, this is a companion volume to *Research Methods*. Summary of the standard measurement and evaluation instruments to determine program outcomes. 1960. 112 p. $2.00.

EVALUATION STANDARDS AND GUIDE

Revised edition of NCATE standards and guide for evaluating college and university programs in health, physical, and recreation education, 1960. 32 p. $1.00.

AMERICAN ACADEMY OF PHYSICAL EDUCATION

Papers and reports presented at annual meetings.

Professional Contributions No. 2. 1952. 88 p. $1.50.
Professional Contributions No. 3. 1954. 144 p. $1.50.
Professional Contributions No. 4. 1955. 99 p. $1.50.
Professional Contributions No. 5. 1956. 69 p. $1.50.
Professional Contributions No. 6. 1957-58. 160 p. $2.00.

Order from: AAHPER, 1201 - 16th St., N.W., Washington 6, D. C.